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FINLAND'S PRIORITIES IN SCIENCE POLICY

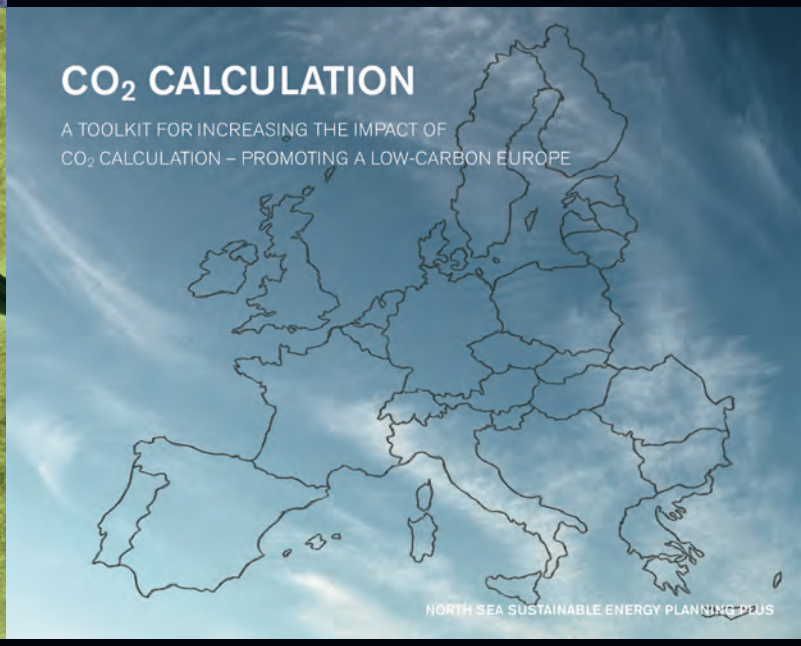
HANNA KOSONEN, MINISTER OF SCIENCE AND CULTURE, FINLAND, DETAILS FINLAND'S PRIORITIES IN SCIENCE POLICY

IN THIS ISSUE

TO DO

DEVELOPMENT OF CULTURAL AND CREATIVE INDUSTRIES IN PRACTICE

Welcome to a handbook that addresses you who work with regional development of cultural and creative industries! For example you, Eva Leemet at Creative Estonia or you, Michal Hladky at Kosice 2013, or you, Jone Zubiaga at Creativity Zentrum in Bilbao who showed great commitment and interest in this method handbook. We are writing for people like you who create fertile ground.



GREEN SHIFT

A HANDBOOK FOR ENVIRONMENTALLY FRIENDLY REGIONS IN EUROPE

This book is about the challenges and opportunities related to the green shift; that is to say, the necessary transition to the low-emission society the world needs in order to limit global warming to two degrees. The book provides a short overview, based on the most recent reports issued by the UN Panel on Climate Change, of the global problem posed by climate change.

CO_2 CALCULATION

A TOOLKIT FOR INCREASING THE IMPACT OF CO_2 CALCULATION

This toolkit is a product of an international cooperation project named North Sea Sustainable Energy Planning PLUS. With the aim of promoting a low-carbon Europe and increasing the impact of CO_2 calculation, partners from six countries have worked together to create this source of inspiration. The project was part funded by the European Union programme Interreg IV North Sea Region.

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FOREWORD

Judith Vorbach
Austrian Member
European Economic and Social Committee (EESC)

The European Union (EU), while not yet fully recovered from the financial and economic crisis, is facing another fundamental challenge: climate change and final awareness of the planet's boundaries. Moreover, digitalisation is expected to cause a major economic transition.

On top of this, the EU still seems underprepared to manage possible economic shocks. At this stage, important decisions on shaping economic policy are being obstructed by differences of opinion as to what direction they should take. It hinges on a conflict over risk sharing and risk reduction.

A resilient society can face shocks and persistent structural changes in such a way that it does not lose its ability to deliver societal well-being in a sustainable way, according to the Joint Research Centre of the European Commission. In this sense, the European Economic and Social Committee, which I am a member of, sees a need to tackle shocks as well as disruptive effects stemming from fundamental technological changes and a need to stop transgressing environmental boundaries to ensure resilience. Article 3 of the Treaty on the European Union, however, gives us a vision that goes further, as it refers among other things to promoting a competitive social market economy, aiming at full employment and social progress.

Today, in 2019, we need to focus on sustainable and inclusive growth, reducing social inequalities, upward convergence, competitiveness in line with the objectives of the Europe 2020 strategy, an investment-friendly environment, quality jobs and pay, combating poverty and social exclusion, sustainable public finances, a stable financial sector and achieving the United Nations Sustainable Development Goals, as well as the goals of the Paris Agreement on climate change. More ambitious action in the context of reforming the European Union's Economic and Monetary Union (EMU) is needed, to achieve a more integrated, more democratic and socially better-developed Union.

Although considerable progress towards completing EMU has been made, we have now ended up somewhere around the halfway mark along the road. There is an urgent need to reinforce and at the same time balance the highly interconnected pillars, which are the basis for a well-functioning EMU:

We need a stable monetary and financial pillar as a basis for macroeconomic development. Decisive steps to complete the Banking and Capital Markets Unions can contribute to that. They must take into account the social and environmental impact of the rules in place, prioritise consumer protection and aim to avoid the burdening of public budgets in a crisis. Strengthening the international role of the euro and the consolidation of the European Central Bank's stabilising role should accompany these steps.

A strong economic pillar as a basis for prosperity and social progress is also needed. It can be achieved by balancing supply and demand measures. This currently

"Strengthening the international role of the euro and the consolidation of the European Central Bank's stabilising role should accompany these steps."

entails boosting the demand side by securing purchasing power through well-paid jobs, which requires strengthening social partners´ collective bargaining systems and autonomy. Other crucial aspects include provisions for sufficient public investment and the creation of a fiscal capacity to buffer shocks. The latter should be funded by a common debt instrument. Stemming harmful tax competition and the prevention of tax evasion and avoidance will make another important contribution to a strong economic pillar.

I am also convinced that the social pillar must be expanded as a basis for societal progress. Minimum social standards, making greater use of the social scoreboard in the European Semester and implementing the European Labour Authority rapidly are all crucial for this purpose.

Finally, a political pillar as a basis for democracy, solidarity and unity should be reinforced. Enhancing the involvement of the European Parliament, social partners and other civil society organisations in key social and economic policy decisions, solidarity and the willingness to compromise – which are basis for EU's prosperity – are the necessary elements for that. ■

Jonathan Miles
Editor

Production Coordinator
Emma Faulkner-Dunn

Designers
Andrew Bosworth
Ben Green

Sales
Debbie Cotterill
John Hoinville
Elena Adirkova

ADJACENT
DIGITAL POLITICS LIMITED

Adjacent Digital Politics Ltd
Datum House
Electra Way
Crewe Business Park
Crewe
Cheshire CW1 6ZF

Registered in England & Wales.
Company Reg No. 8667479.
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INTRODUCTION

Welcome to the largest ever edition of Open Access Government to date, I trust that you enjoy the myriad of insights that are offered here on a fascinating spectrum of policy issues.

One of our major focus areas is health and social care. In this vein, we feature three articles from the World Health Organization. The first is by Monika Kosinska, Programme Manager, Governance for Health Division, who explains why the air we breathe is Europe's silent killer. The second is by Jean-Marie Dangou from the WHO Regional Office for Africa, who details the prevalence of diabetes is in the African region, including the lack of access to proper treatment and diabetic medications. The third is my exclusive interview with Prof Olufunmilayo Lesi, Regional Medical Officer for Viral Hepatitis from the WHO Regional Office for Africa, who discusses the priorities for tackling viral hepatitis in the region.

Heading up our research and innovation focus, Hanna Kosonen, Minister of Science and Culture, describes Finland's priorities in science policy. Also, we are honoured to enjoy a return appearance by Frédérique Vidal, Minister of Higher Education, Research and Innovation in the French Government. This time, the Minister shares her thoughts on how European universities will aim to define a common and long-term strategy for 2025 in training, research and innovation.

Farther on in this publication, we welcome Mauro Petriccione, Directorate-General for Climate Action at the European Commission, who discusses how the EU and Japan are cooperating on innovation in the clean energy transition and climate action. On the subject of energy, regular contributor Morry Markowitz, President of the Fuel Cell and Hydrogen Energy Association, underlines all we need to know about the National Hydrogen and Fuel Cell Day on October 8th and beyond that.

Finally, in one of several UK Government pieces featured here, we include comment from Simon Hart MP, Minister for Implementation at the Cabinet Office, who underlines an aspect of his brief that concerns managing the government's relationship with commercial suppliers, focussing on the importance of prompt payments.

Do get in contact with me if you any suggestions for policy-themed content for future editions of Open Access Government, with many more ahead in January 2020 and beyond.

Jonathan Miles
Editor

@Jonathan_AdjDig

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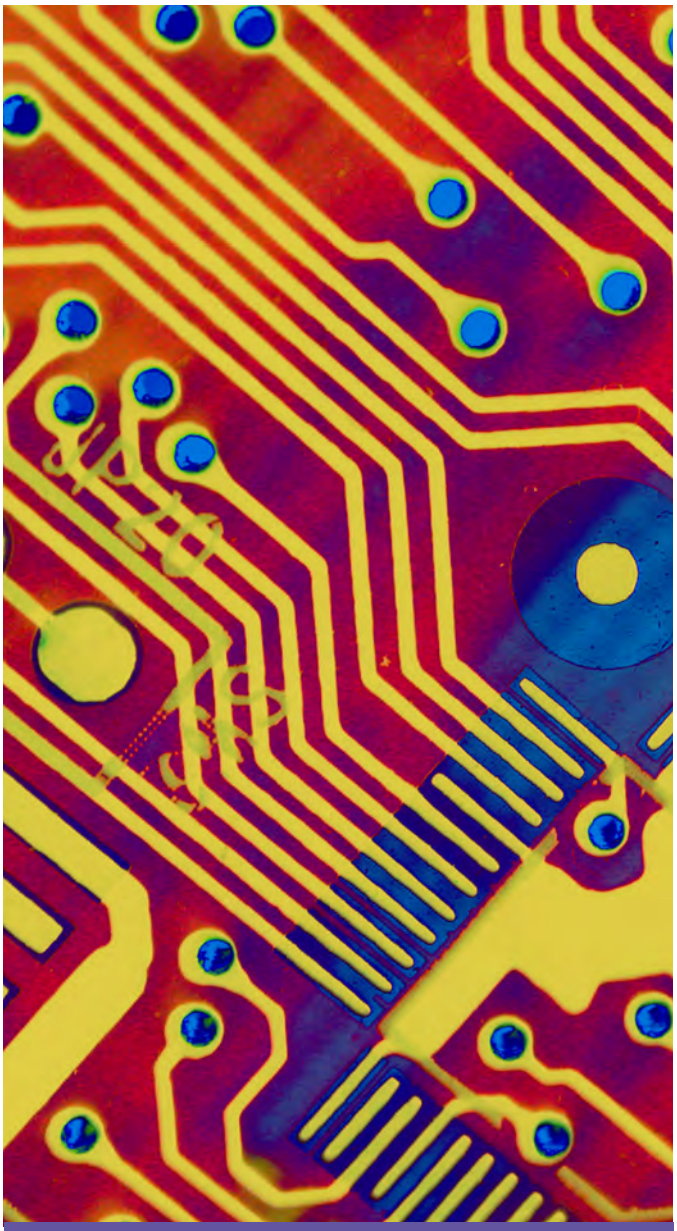

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Europe's silent killer: The air we breathe

Monika Kosinska, Programme Manager, Governance for Health Division at the World Health Organization explains why the air we breathe is Europe's silent killer

Toxic air is a "silent global public health emergency" according to the World Health Organization (WHO) Director-General, Dr Tedros Adhanom Ghebreyesus, that is on the scale of smoking. Nine out of ten people now breathe polluted air that kills seven million people each year.

The alarming damage to health from air pollution can be measured by the fact that the hearts of young people living in cities contain billions of toxic air pollution particles – even in a child as young as three. This health burden is falling on our most vulnerable populations – children, as well as lower status socioeconomic groups and excluded communities. Air pollution is the cause of one-third of deaths from stroke, lung cancer and heart disease. It has even surpassed physical inactivity, alcohol misuse, obesity and as a risk factor for noncommunicable diseases (NCDs) to become the second leading cause of death from NCDs.

> "Investing in healthier cities in order to reduce air pollution and the incidence of NCDs can also trigger a multiplier effect leading to various co-benefits for both well-being, climate change and the environment."

As much as 68% of the world's population will be urban by 2050 compared with 55% now, according to UNESCO. And it is urban areas that are clogged with rising levels of air pollution as cities get hotter and more crowded – and traffic levels mount. This raises the questions of what type of disruptive change could help cities tackle the serious problem of air pollution and subsequently the growing burden of NCDs and how urbanisation can progress in a more sustainable way.

Even though air pollution is typically thought of as a by-product of megacities in Asia, levels in Europe are in fact higher than the global average. In 2016, over 550,000 people died prematurely across the continent because of dirty air. A recent study in the European Heart Journal even suggests numbers could be as high as 800 000 annually.

The high level of urbanisation (74%) is the reason for Europe's bad air quality – and estimates say that by 2050 this could reach virtually 84%. To help find solutions we must first and foremost differentiate between ambient and indoor air pollution. The former results predominantly from emissions from transport, energy and industrial activities, the latter from burning fuel for cooking, heating and lighting.

As individuals we can help by, say, walking or cycling as our main mode of transport or by generating their households' energy needs by using solar power, but most sources of air pollution are well beyond an individual's control. They instead require a concerted multi-stakeholder approach at local, national and regional level across sectors such as transport, energy, industry, waste management and urban planning.

European capital cities, such as Copenhagen, Paris, Oslo and Helsinki, have recently adopted various initiatives to tackle air pollution, especially within transport. In Copenhagen large areas are closed to vehicles, the city has invested heavily in cycling lanes and even opened its first sole bridge for cyclists in 2014: it plans to be completely carbon neutral by 2025. Paris banned cars from major historic central districts on weekends and made public transport free during major events.

Clean technologies

Successful policies and investments for combatting air pollution include clean technologies to reduce industrial smokestack emissions, urban and agricultural waste

management to capture methane gas emissions, increased use of solar, wind and hydropower for energy generation. Cities, in particular, can become more sustainable and health-promoting by prioritising rapid urban transit and cycling networks for its citizens, increasing the energy efficiency of building, encouraging waste separation and recycling and setting up urban green spaces.

> "Awareness of the global health threat posed by air pollution has gained momentum in recent months. The first-ever global conference on air pollution and health took place last autumn and it will also be among the key topics of this year's European Health Forum Gastein."

The tricky thing is that local and national solutions alone are not sufficient to tackle the problem of air pollution as dirty air does not halt at national borders. Transboundary air pollution as it is known can affect people's health and well-being thousands of kilometres away from its source. Hence, there is a serious need for joint international efforts, notably through environmental agreements such as the United Nations Economic Commission for Europe (UNECE) Convention on Long-Range Transboundary Air Pollution (CLRTAP) and policy platforms, such as the European Environment and Health Process (EHP).

Similarly, in 2017, 53 countries signed the Ostrava Declaration which urged enhanced action to combat the 1.4 million premature deaths ascribed to environmental factors, notably by improving air quality. It encourages European countries to support cities to become healthier and safer by fostering sustainable and health-promoting urban planning and mobility management.

Investing in healthier cities in order to reduce air pollution and the incidence of NCDs can also trigger a multiplier effect leading to various co-benefits for both well-being, climate change and the environment. Expansion of public transport, cycling networks and

walkways not only reduces air pollution but also increase individuals' physical activity which is one of the key measures to prevent NCDs.

Consciousness-raising

Awareness of the global health threat posed by air pollution has gained momentum in recent months. The first-ever global conference on air pollution and health took place last autumn and it will also be among the key topics of this year's European Health Forum Gastein (EHFG).

The annual conference, taking place in early October in Bad Hofgastein, Austria, brings together key European politicians, researchers, civil society and industry representatives and journalists to discuss Europe's most pressing health issues and stimulate action for radical change.

Obviously, talking the talk is not enough. Urbanisation, both in Europe and globally, will accelerate in the decades to come so all relevant actors from government, industry, civil society and the public as a whole need to come together to tackle the omnipresent, yet invisible threat air pollution represents for all of us. ■

Monika Kosinska
Programme Manager, Governance for Health Division
World Health Organization (WHO)
Advisory Committee of the European Health Forum Gastein (EHFG)
eurohealthycities@who.int
www.euro.who.int/en/home
www.twitter.com/who_europe

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Academia: An important player in the drug discovery ecosystem

Dr Richard Angell and Dr Jane Kinghorn from the Drug Discovery Group (Translational Research Office), at University College London (UCL), explain the value of drug discovery in academia in bridging the "Valley of Death"

The decline in productivity of large pharmaceutical companies over the past two decades and their evolution towards more open and collaborative models has been well documented[1,2]. The result of years of downsizing has been the fragmentation of infrastructure required for developing novel small molecules. Highly skilled applied scientists with drug discovery know-how and expertise can now be found in a number of new spin-out therapy companies, Contract Research Organisations (CROs), not-for-profit organisations and also within dedicated Drug Discovery Groups (DDGs) within academia. This new dynamic ecosystem is positioned to actively de-risk early drug discovery through public funding, charities, philanthropy, private-public partnerships and venture capitalist funding. Such collaborative research environments help to overcome common pitfalls in drug discovery where new compounds often fail, known as the "Valley of Death"[5].

Analysis of FDA approved new chemical entities and the role universities have played in their identification and development indicates anything between 24 to 55%[1]. Nearly a fifth of drugs recently approved by the EMA originated from academic and publicly-funded drug discovery programmes[3]. With large pharma reassessing priorities every two to four years and aligning behind an ever decreasing set of disease areas and indications, large areas of unmet need are now poorly served. Universities are well-positioned to address the gaps. With a diverse set of expertise, access to large sets of data, access to patients, all set in an innovative and creative environment, professionalised DDGs in academia are well placed to advance novel targets, incorporate the latest technologies to de-risk drug discovery projects and progress those projects using robust, industry-standard approaches.

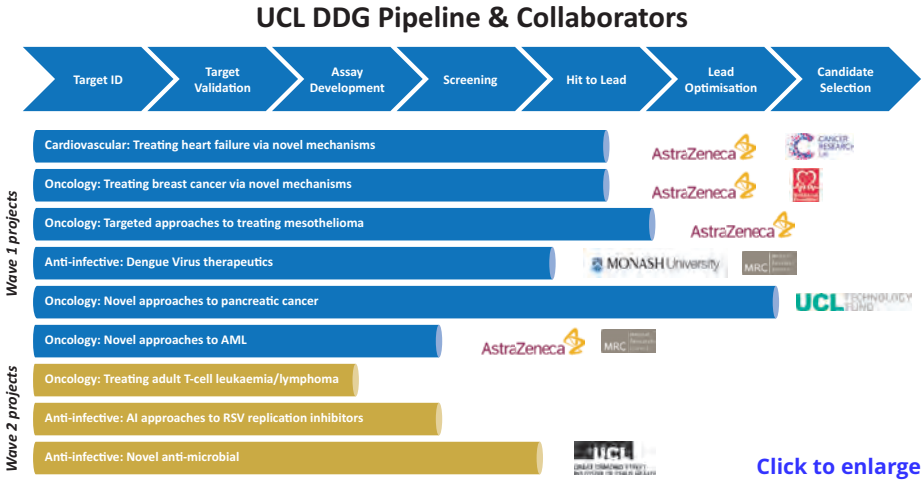
The **"Valley of Death"** is often described as the gap between a promising early-stage academic discovery and the later-stage de-risked project that will attract the attention of pharmaceutical companies and investors. Bridging this gap can be a significant challenge in an academic environment[5]. In a recent report from the ABPI,[4] it was noted that 24 publicly funded drug discovery centres exist in the UK, employing over 500 staff, with the capacity to carry out over 350 screening projects per year. In the U.S., there are approximately 60 such academic translational centres that have received significant funding from the National Center for Advancing Translational Science, National Institutes of Health[5].

Drug discovery at University College London

The Drug Discovery Group (part of the UCL Translational Research Office) is an industry-experienced team of drug discoverers with the task of seeding new drug discovery projects within UCL, focusing on UCL-initiated science. The team collectively has over **40 years of small molecule drug discovery experience** across a range of environments from small biotech through to academic groups, research institutes and pharma companies and is positioned within the internationally renowned UCL School of Pharmacy.

Over the past five years, the DDG has established infrastructure to support assay optimisation and cellular and biochemical screening, including the capability to miniaturise assays to 384 and 1,536 well formats and access to screening collections including the AZ Open Innovation library through a strategic collaborative agreement with UCL, brokered by the team. In-house chemistry capabilities include an array of automated purification equipment including Biotage Isolera and Waters prep LC/MS. The team also has extensive experience of out-sourcing research requirements as necessary, including specific hit compound expansion, biophys screening and in vitro and in vivo DMPK studies.

The team are ideally placed to take advantage of UCL's collaborative ethos between clinician-scientists, patients and academic scientists, translating curiosity-driven academic research into drug discovery projects. This is particularly aided by close ties to our



The Drug Discovery Group's successful pipeline within UCL currently consists of 9 projects spanning across early stage drug discovery – from target identification and validation, through assay development, screening and hit-to-lead, to lead optimisation and candidate selection.

three National Institute for Health Research Biomedical Research Centres (BRCs) providing a unique ecosystem that supports clinical target identification and validation through building a rich repository of patient data and opportunities for experimental and translational medicine. The DDG is currently working with bioinformaticians to enable the intelligent use of data for improvements to target validation and drug design, helping to de-risk the projects the team select to work on.

Current Portfolio

To date, the team has established a portfolio of projects (Wave 1) built upon UCL-based research (Figure). The primary focus has been the cardiovascular, anti-infective and oncology projects, many enabled by Open Innovation collaborations with AstraZeneca. Most of these projects have progressed to validated hit series and are currently seeking on-funding to enable further progression. A second wave of projects are continuing to mature and the team are establishing drug discovery approaches or confirming data associated with early tool compounds.

Funding Models for Academic Drug Discovery

Currently, the team has a mixed funding model with underpinning funds provided by UCLH BRC and Wellcome Trust Infrastructure Strategic Support Fund, supplemented by additional funds from competitively won research applications. These have included awards from UCL Technology Fund, British Heart Foundation, CRUK Drug Discovery Committee, MRC Confidence in Concept and Proximity to Discovery funds.

However, this funding model and, in particular, applying for funding on a project-by-project basis, does not allow the flexibility required to accelerate project progression. A lack of sustainable funding to enable rapid progress in academic drug discovery has been repeatedly recognised in Europe[6], U.S.[7], as well as by the Academy of Medical Sciences in the UK[8] who recently highlighted the need to propagate a culture change in funding for discovery activities to establish more flexible, long-term financial and resource commitments.

Moving forward, the DDG at UCL are actively exploring diversification of their funding model to move towards a sustainable funding stream. The team are exploring flexible portfolio finance opportunities from various sources including VC, public money, charities and philanthropy in return for risk sharing in the portfolio and identified projects as they mature. If you are interested to participate in exciting, novel early drug discovery, then please get in touch.

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Dr Richard Angell
Head Drug Discovery Group,
Translational Research Office
University College London
Tel: +44 (0)207 753 5973
r.angell@ucl.ac.uk
www.ucl.ac.uk/translational-research/
www.twitter.com/UCLTRO

Promoting public health in the European Union Member States

Here, we take a look at some recent examples of how public health in European Union Member States has been supported by the outgoing European Commissioner for Health & Food Safety, Vytenis Andriukaitis

Vytenis Andriukaitis [1], the current European Commissioner for Health & Food Safety will soon be replaced by Stella Kyriakides [2] for the 2019-2024 period. During the 2014-2019 period, Vytenis Andriukaitis's responsibilities included building up knowledge on how national health systems perform, to mould both national and European Union (EU) policies. Another concerns the increased calls on national health services during a time when there is intense pressure on public finances. [3]

The concept of healthy lifestyles

Commissioner Andriukaitis took part in a high-level 'Healthcare Innovation for the future' meeting on 9th September 2019. Here, he stressed the importance of paying attention to, "the protection, prevention and promotion of health, to the economy of health, health and wellness 'valleys' or infrastructure", as well as the creation of networks of healthy cities and villages and nutritional policies. One area the Commissioner highlighted is about incorporating the concept of healthy lifestyles in the creation of all businesses, a point he explained in his own words.

"We have to include the concept of healthy lifestyles in creation of every business. I think it is time the industry does not 'business as usual but business as healthier'. This would be such a life changing progress. And the only way to move to healthy ageing goal.

"Public health instruments have to be realised in a coherent way.

"And it means real 'health in all policies' approach. It requires a wide range of different measures: taxation, marketing and advertisement regulation, education and infrastructure, just mentioning a few.

"It has to be done at all levels – EU, national, regional and local – all together, but based on evidence of effectiveness of public health instruments. Ant the participation of all actors involved here is crucial."

Public health

When it comes to concrete actions implemented on the EU level in public health, Commissioner Andriukaitis draws our attention to the Alcohol Strategy,

the provisions of which still need to be implemented and there is more work to be done here. Despite this, the Commissioner underlines some good examples that can be implemented and encourages the Member States to follow these examples.

"We congratulate Scotland's pioneering policy of minimum pricing for alcohol, which has been successfully implemented. That is life-saving legislation. Excellent example and precedent for other Member States.

"Another good example – Irish Public Health legislative framework designed to tackle Ireland's harmful relationship with alcohol. It aims to reduce the damage that alcohol causes to individuals, families and society by reducing alcohol consumption, with a particular focus on protecting children and young people from alcohol harm.

"The EU expressed positive support to those measures and encouraged Member States to follow those examples."

The Commissioner added that the EU can support the policies of the Member States concerning alcohol-related harm by, for example, the reduction of aggressive online marketing to underage and adolescents, supporting unbiased information through labelling and increasing access to food and drink choices.

Healthcare innovation

Finally, on other public health initiatives, Commissioner Andriukaitis explained that the European Commission has developed an innovative approach in the field of public health. One of the examples he used in this respect, was the State of Health in the EU, a permanent two-year European Commission project that gives policymakers, health practitioners and interest groups insights into health and healthcare and cure systems in EU countries, as well as actual and comparative data. The Commissioner then explained why this approach is helpful.

"It helps to prepare annual Country Specific Recommendations to Member States. Together with the next MFF, the proposed regulation on the European Social Fund Plus provides a key governance role for the Steering group for more upstream consultation with the health authorities."

Commissioner Andriukaitis added that a good example of that is the Swedish 'Physical Activity on Prescription', which will be really useful if transferred to Belgium, Germany, Denmark, Italy, Lithuania, Malta, Spain, Portugal and Romania. Having said that, he stressed the need for the Member States to have the same definition of health in front of their eyes. This is an appropriate note to end this article on as it speaks about 'the health in all policies' approach, which is part of the tremendous legacy that Commissioner Andriukaitis leaves. I am sure you would like to join me in wishing him well for the future and his replacement, Stella Kyriakides for the 2019-2024 period.

"But first of all, we have to look in the same direction, to have same values and health definition in front of our eyes:

'Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity.'

"It means – we need to look at it through 'Health in all policies' approach. The Commission tries to implement 'the health in all policies' approach." [4]

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Jonathan Miles
Editor
Open Access Government
editorial@openaccessgovernment.org
www.openaccessgovernment.org
www.twitter.com/OpenAccessGov

Horizon 2020 research: The health innovation ecosystem of Europe

Here, Cecile ten Kate discusses the process of valorisation of research projects, focusing specifically on the health innovation ecosystem

Bringing research to life and seeing it translated into real-world impacts, such as bringing important innovations to patients, is a complex process, in which many innovators fail. Evaluations of FP7 and completed health-related Horizon 2020 projects found that an estimated 80% of the results lacked real progress in terms of valorisation and advancement towards the market. This is a missed opportunity as health innovation is one of the major drivers of future growth in the knowledge-based economy and innovation in healthcare is crucial for providing benefit to citizens, as well as meeting established European priorities.

Several barriers are impeding the process of valorisation of EU-funded projects. These can relate to general barriers refer to barriers that hamper valorisation of research results in the life sciences industry or specific barriers that hamper valorisation specifically for FP7 Health and H2020 SC1 project results. For instance, once a project has ended, there is no mechanism in place to ensure that grant beneficiaries make any effort to carry out the proposed post-project exploitation or commercialisation plan and it may not be the case that all of the partners involved are otherwise incentivised or interested to keep the project going. In all cases, these barriers relate to the way the Health Innovation Ecosystem is organised.

The H2020 funded project UTILE (www.health-breakthrough.eu), is aimed at facilitating activities that translate promising health-related research results into innovations that will reach the market and have an impact on the healthcare system. This initiative presents the EU-Health Innovation Marketplace, which references all types of innovations with potential for future exploitation and/or commercialisation, primarily generated by EU Seventh Framework Programme (FP7) and Health and Horizon 2020 SC1 programmes. The UTILE Marketplace matched parties developing new innovations (partners within European projects, including academic research organisations, SMEs and large organisations) and organisations that act as facilitators for these innovations (including industry representatives, advisors, entrepreneurs, investors and other collaborative parties) and are searching for new research or business opportunities.

Valorisation of research does not take place in a vacuum, but rather through a series of steps and processes that depend upon various important partners and stakeholders and with access to various resources including not only know-how, experience and expertise (human capital), but also facilities, networks, financial resources and more: in short, valorisation requires an ecosystem in which it can take place. The fundamental rationale for designing the UTILE Marketplace as well as the other services UTILE provide finds its background in, what we investigated, is an effective Health Innovation Ecosystem.

Health Innovation Ecosystem

Within UTILE, we developed a framework and outlined conditions for the development of an effective Health Innovation Ecosystem within Europe via feedback and insights from the UTILE Market and Stakeholder Advisory Committee (MSAC) consisting of Europe's respected and experienced industry, investment and other innovation stakeholders. The developed framework distinguished four important elements for an effective Health Innovation Ecosystem and identified the perspective of experts in the field regarding these elements.

The four elements that make up the developed framework for an effective Health innovation Ecosystem within Europe are: 1. Excellent Science, 2. Access to capital, 3. Access to human capital and 4. Culture of innovation. Within UTILE, we investigated through interviews and round tables discussion the extent to which the relative supply of these elements, or lack thereof, are perceived as barriers to innovation within Europe. As is visualised in Figure 1, the major barriers are perceived for 3. Access to human capital and 4. Innovation culture & incentive.

1. Excellent science – no barrier perceived: Europe generates a great deal of world-class science. There is, therefore, no relative lack or absence

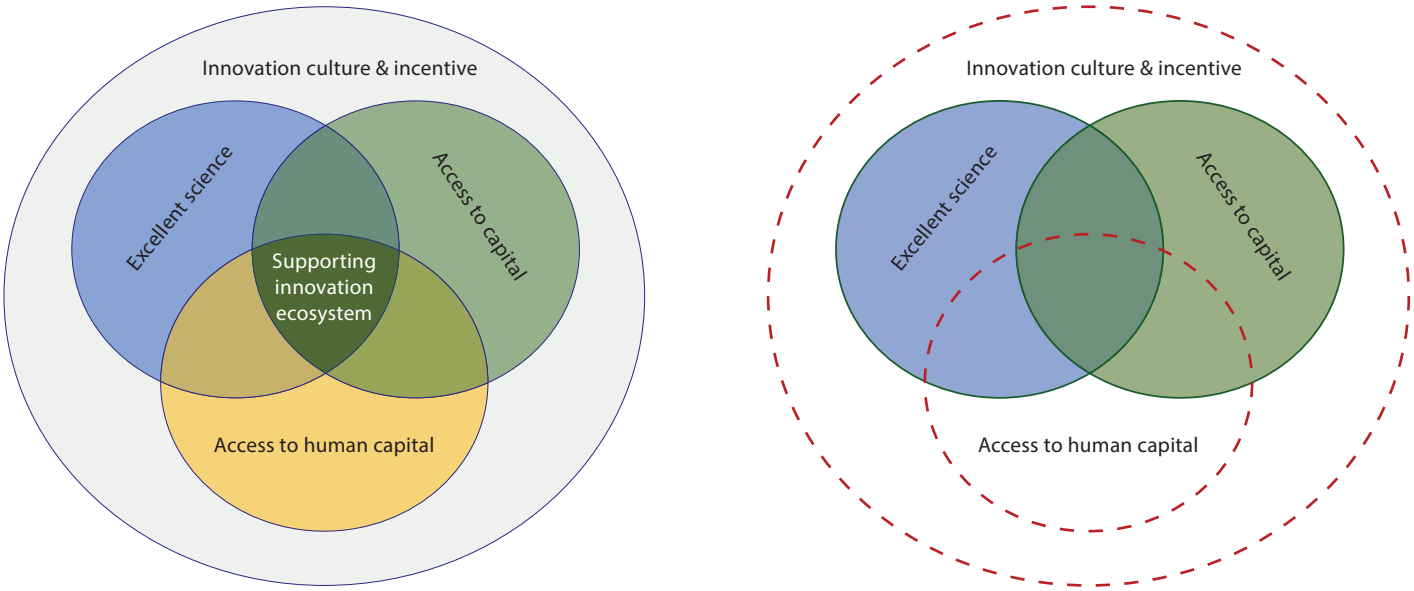


Figure 1 – Elements contributing to an effective Health Innovation Ecosystem and their status in Europe as perceived by experts in the field. Left: the four elements. Right: the four elements as perceived in Europe.

of world-class science in Europe which hinders or presents a barrier to the development of a strong health innovation ecosystem. Europe and the Member States should strive to maintain or improve the existing strong commitment to fostering world-class science in order to ensure that a current strength is not allowed to deteriorate and become a weakness.

2. Access to capital – no/minor barrier perceived: Although there is room for improvement, access to capital in Europe for health sector innovation is not really the rate-limiting factor it is often made out to be. In particular, earlier stage capital is relatively more accessible in Europe than is generally the case in bioregions globally (exception for the leading global hotspots). There is be a minor barrier within Europe in that capital is more accessible in the more mature health clusters and financial centres than in the smaller regions and this is particularly the case with regard to development, late-stage and growth capital, hence there is a minor barrier and access to capital, especially later-stage capital, could be improved across European markets. Specific measures were proposed.

3. Access to human capital – major barrier perceived: Access to human capital has been identified as a major barrier to the effective valorisation of research results and innovation within the European health innovation ecosystem. Our investigation indicated that "mediators" are important players in an effective innovation ecosystem. Mediators are those whose professional role facilitates the translation of research results or innovation from academia and research, towards the market. While many such mediators are present in Europe, there are two general problems: First, many mediators are clustered in the more developed and mature bioregions and second, the necessary networks designed to connect these mediators with innovation stakeholders are often lacking or sub-optimal. Any given region of the European health innovation ecosystem may be impacted by one or both of these challenges. A number of specific measures were proposed.

4. Innovation culture & incentive – major barrier perceived: The general lack of a sufficiently strong culture of innovation culture within academic and clinical settings, not only amongst researchers and clinicians but among administration and decision-makers, as well as a lack of commitment to a culture that fosters valorisation or research results have been identified as important barriers to Europe's health innovation ecosystem. The main possible contributing factors included: 1) a lack of return on investment in terms of value for career advancement and the prioritisation of publication over research valorisation and 2) a lack of perceived value or incentivises of commitment to valorisation in terms of impact on access to research funding.

One of the final UTILE deliverables will be a series of policy recommendations addressing a number of issues but strengthening the European health innovation ecosystem will feature prominently and more attention will be paid to proposed solutions.

Cecile ten Kate
Senior consultant
TTOPSTART/PNO
Tel: +31 629 558 838
cecile.tenkate@pnoconsultants.com
www.pnoconsultants.com

Idiopathic pulmonary fibrosis: An incurable lung disease

Steve Jones, Chair Action for Pulmonary Fibrosis and Board Member EU-IPFF and Professor Gisli Jenkins from Nottingham University Hospitals, explain idiopathic pulmonary fibrosis (IPF), a silent killer and incurable lung disease in which scars are formed in the lung tissues

Idiopathic pulmonary fibrosis (IPF), is an incurable lung disease in which scars are formed in the lung tissues. It is a devastating condition characterised by increasing breathlessness, disability and death three to four years after diagnosis[1]. Only 25% of people survive for five years. IPF has a worse prognosis than most cancers.

Over 30,000 people in the UK live with IPF and over 5,000 people a year die from IPF. It is remorseless and the fourth biggest respiratory killer after lung cancer, COPD and pneumonia[2]. IPF kills more people in the UK than leukaemia[3], but few people have heard of the disease. It generally occurs in people over 50 years of age and affects men more than women. Unlike many respiratory diseases, it is spread evenly through all sections of society.

We do not know the precise cause of IPF, but scientists believe it is triggered, in people with a genetic predisposition, by exposure to cigarette smoke, dust and pollution. Acid reflux from the stomach may also play a role. Similar progressive fibrotic diseases, where the cause is known to include asbestosis and farmer's lung disease. Epidemiological research indicates that the incidence of IPF is increasing rapidly at 2-3% annually[4]. The reason for this is not clear.

Inequalities in care and treatment

IPF generally starts slowly and patients often receive treatment for other conditions, such as chest infections, asthma and heart failure, before they get the IPF diagnosis. GPs misdiagnose up to 35% of patients, which delays referral to hospital respiratory specialists[5].

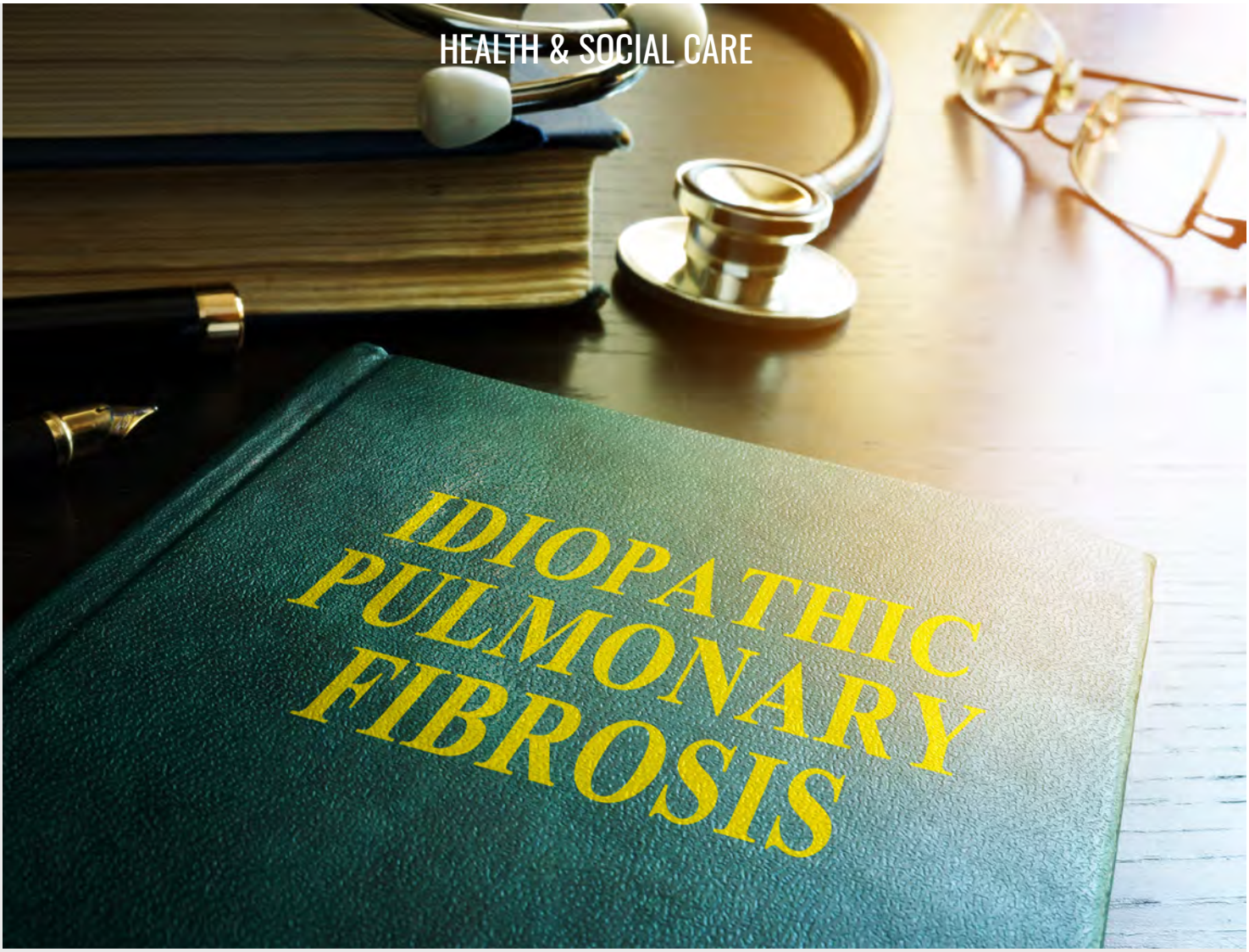
Long NHS waiting times for hospital appointments also delay diagnosis and treatment. Fewer than 50% of patients get the diagnosis within six months of their first visit to their GP and for 20% of patients, it takes over two years[6].

Although IPF has such a poor prognosis, patients do not receive the same level of care as cancer patients. Cancer patients have a clear pathway designed to ensure timely and accurate diagnosis and treatment. They must start treatment within 62 days of a GP's referral and are provided access to a specialist nurse. The timeline for IPF patients is less strict – patients only have to be seen by a hospital doctor within 18 weeks. IPF patients who attend one of the 23 specialist centres in England generally have access to a specialist nurse, but this is often not the case at district hospitals.

> "Patient support groups can play a vital role in helping patients and their families overcome this feeling of loneliness and find support. They also provide an opportunity for patients to learn more about the disease and feel empowered to manage it better."

Two anti-scarring drugs are available, which slow down the progress of the disease. These are expensive and have a number of side effects. The National Institute of Health and Care Excellence (NICE) has approved anti-scarring drugs for use with patients with a lung function criteria (force vital capacity between 50% to 80% of predicted value). This means that the drugs cannot be prescribed to early-stage patients with a lung function of over 80%. This restriction is of great concern to patients and their families. The UK is the only country in Europe where this is the case. In other countries, patients may be prescribed these drugs immediately after diagnosis.

As well as anti-scarring drugs, people with IPF may be



offered pulmonary rehabilitation (involving exercise classes and education), cough suppressants and oxygen therapy to help alleviate some of the severe symptoms such as fatigue, cough and breathlessness associated with IPF.

As the disease takes hold, patients become more and more breathless. Initially, they are unable to climb stairs and eventually find walking on the flat difficult. They become dependent on supplementary oxygen. Their world closes in on them and they feel isolated.

Patient support groups can play a vital role in helping patients and their families overcome this feeling of loneliness and find support. They also provide an opportunity for patients to learn more about the disease and feel empowered to manage it better. Support group are generally run by patents and health care professionals, such as nurses or physiotherapists.

Patient charities, such as Action for Pulmonary Fibrosis, in the UK, have galvanised the community by raising money, funding research, helping to set up over 75 local support groups and providing educational resources for patients, carers and healthcare professionals. Similar patient organisations exist in other European countries, the U.S. and Canada.

Hope for the future

Despite the grave prognosis, there is considerable hope for patients with IPF. There are a large number of new anti-scarring drugs being developed to treat this condition. Furthermore, new genetic insights into the disease have raised the prospect of precision medicine using targeted treatments tailored to patients with specific genetic or molecular abnormalities.

Artificial intelligence (AI), as well as wearable and other smart technologies, may help identify patients earlier, who may then gain more benefit from starting these new or conventional therapies sooner.

Although IPF is a deadly disease and is killing more and more people each year, increased collaboration between doctors, scientists and patient advocacy groups is leading to real improvements in outcomes for

A European Patient Charter on best practice in IPF care and treatment

The European Idiopathic Pulmonary Fibrosis and Related Disease Federation (EU-IPFF) was set up in 2013 by patient advocacy groups from different countries and leading clinicians to launch a European Patient Charter on best practice in IPF care and treatment. Since then, it has grown into an important platform for sharing best practice, educating its members and raising awareness among policymakers in the European Parliament and European Commission.

The EU-IPFF promotes the collective partnership of patient groups, health care, professionals, academia and industry. It is in turn supported by larger groups in which it is active, such as European Lung Foundation, Eurordis (Rare Disease Europe) and the European Reference Network on Rare Respiratory Diseases (ERN-Lung), in turn, support EU-IPFF. It has a Scientific Advisory Board comprising leading clinicians and scientists from across Europe.

A benchmarking study of IPF care and treatment across Europe, which highlights areas for improvement in different countries, has recently been completed by the EU-IPFF. In 2020, it will organise the first European IPF Patient Summit on idiopathic pulmonary fibrosis (IPF) and interstitial lung diseases (ILDs). This will bring together patient groups, healthcare professionals and industry representatives to discuss research, person-centred care, policy and advocacy for IPF and ILDs.

Liam Galvin
Secretary
EU-IPFF
liam.galvin@eu-ipff.org
www.twitter.com/eu_ipff

patients with this devastating disease. This is happening in the UK, across Europe and globally (see box).

The main challenge facing policymakers, in the years ahead, will be to ensure adequate funding for research on IPF and to pay for costly new treatments needed for rising numbers of IPF patients. ■

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Steve Jones
Chair Action for Pulmonary Fibrosis
Board Member EU-IPFF
chair@actionpulmonaryfibrosis.org
www.actionpulmonaryfibrosis.org
www.twitter.com/ActionPFcharity

Professor Gisli Jenkins
NIHR Research Professor
Consultant Respiratory Physician
Nottingham University Hospitals
Gisli.Jenkins@nottingham.ac.uk
www.twitter.com/IPFdoc

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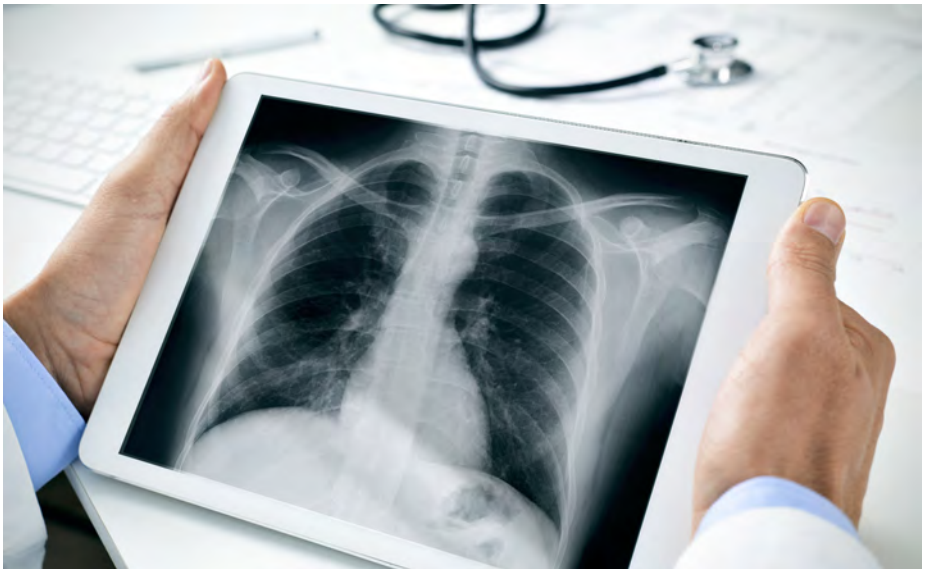
The role of eHealth tools in idiopathic pulmonary fibrosis care and research

Karen Moor and Marlies Wijsenbeek from the Erasmus Medical Center, Rotterdam explore the role of eHealth tools in idiopathic pulmonary fibrosis care and research

Idiopathic pulmonary fibrosis (IPF) is a rare, chronic lung disease with progressive scarring of lung tissue (fibrosis). IPF has a poor prognosis and a devastating impact on the lives of patients and their families. Recently, two anti-fibrotic drugs became available that slow down the decline in lung function (forced vital capacity, FVC) in IPF. Although this is an important and hopeful step forward for patients, IPF remains a deadly disease with a progressively impaired quality of life due to symptoms as dyspnea, cough and reduced exercise tolerance[1].



The use of eHealth technologies could hold great benefits in this elderly population, especially in countries where patients are treated in a limited number of centres and have to travel considerably to visit the outpatient clinic. We believe that eHealth has the potential to improve care and research in IPF as distances are bridged online and data can be collected by the patient at home. The use of eHealth technologies may further promote self-management and provide patients with more insights in their disease course.

Even though the use of eHealth tools to improve health outcomes is being increasingly explored in other (chronic) diseases, experience with eHealth in IPF is scarce. Currently, over 300,000 health apps are available in the app stores, however, most eHealth applications have never been thoroughly investigated.

eHealth is defined as: "The use of information and communication technologies (ICT) for health"[2].

eHealth tools to improve health outcomes in IPF

Together with patients, we have developed a home monitoring programme (IPF online) for patients with IPF. IPF online consists of an app integrated with real-time measurement of lung function at home (home spirometry), online reporting of symptoms, side-effects and quality of life questionnaires, an information library and the possibility of electronic and video consultations[3]. This system incorporates automated email alerts if lung function significantly declines or patients report bothersome side-effects. The real-time monitoring and feedback enable patients to gain more insights into their disease and give clinicians the option to monitor patients at a distance. A pilot study with this system demonstrated high patient satisfaction and indicated that online monitoring of lung function and symptoms is feasible and reliable in this elderly patient population. This study has paved the way for a randomised controlled trial evaluating the effect of home monitoring on quality of life, medication use, side-effects and healthcare costs, which is currently underway (NCT03420235).

Use of home monitoring for data collection in clinical trials

Further, eHealth solutions can be used to enhance data collection in clinical trials. One ongoing study evaluates disease behaviour during the peri-diagnostic period in patients with interstitial lung diseases, including

IPF, using daily home spirometry and accelerometry. Moreover, this study aims to improve collaboration between community hospitals and expert centres using a digital collaboration platform. The results of this study will shed light on the role of eHealth for earlier diagnosis and treatment[4].

> "We believe that eHealth has the potential to improve care and research in IPF as distances are bridged online and data can be collected by the patient at home. The use of eHealth technologies may further promote self-management and provide patients with more insights in their disease course."

Home spirometry may also facilitate endpoint collection in clinical trials studying new treatment options for IPF and other forms of pulmonary fibrosis. A decline in FVC is the primary outcome in most IPF clinical trials and is widely accepted as a surrogate endpoint for mortality[5]. In a rare, progressive disease as IPF, performing large international clinical trials is rather challenging. Studies with new drugs will have to demonstrate efficacy on top of already registered anti-fibrotic treatment. This will lead to smaller margins of change in FVC decline and thereby require a longer duration of studies or larger groups of patients to be studied (increased sample sizes).

Until now, few studies in IPF have focused on the collection of data by the patient at home. Two studies demonstrated that home spirometry in IPF is highly clinically informative and may reduce sample size for future trials[6, 7]. These studies clearly revealed the potential of home monitoring in patients with IPF. However, FVC results were not directly available for healthcare providers, which makes it impossible to check the quality of measurements, monitor adherence and timely respond to a decline in lung function. Currently, a number of IPF trials collect home spirometry data as a secondary endpoint, but results have yet to be published.

Though important as an objective outcome measure, lung function does not necessarily reflect how a patient feels or functions. Patient-reported outcomes can provide more relevant information about the impact of a disease on patients' quality of life and are, therefore, increasingly used as outcome measures in IPF research. One of our recent studies showed that online collection of patient-reported outcomes is feasible for patients with IPF and may be incorporated in eHealth tools[8].

Potential future applications of eHealth in IPF

Multiple national IPF registries have been initiated during the last years, but trans-border collaboration and pooling of data have encountered multiple hurdles so far. An online home monitoring programme has the potential to overcome these barriers, as data about lung function, symptoms, medication and quality of life are collected and owned by patients. These data may be used for registry purposes when patients give their consent. A real-world patient-led registry would provide much-needed insights in disease behaviour of IPF and other forms of pulmonary fibrosis, at a low burden for patients and healthcare providers.

Although recent developments are encouraging, more steps need to be taken in the coming years. For instance, questions about long-term use and cost-effectiveness of eHealth in IPF have still not been answered. Another important issue is whether eHealth solutions could replace outpatient clinic visits in the future and thereby reduce the frequency and burden of hospital visits. To address these topics and integrate eHealth tools in research and clinical practice, better collaboration between patients, healthcare providers, researchers, health policymakers, insurance companies and other stakeholders is needed.

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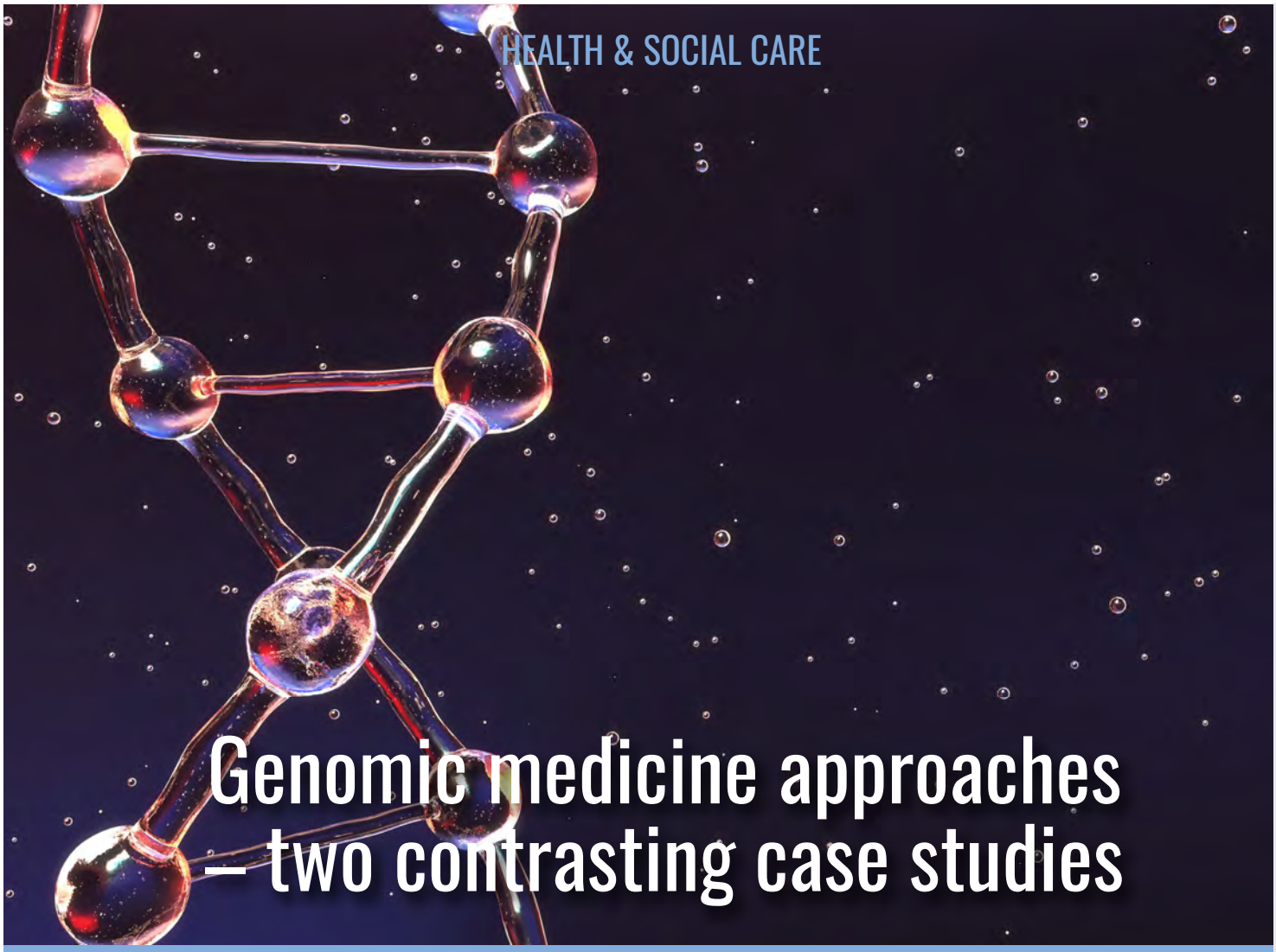
Karen Moor, MSc, MD
PhD Department of Respiratory Medicine
Tel: +31 650 031 750
c.moor@erasmusmc.nl

Marlies Wijsenbeek, Associate Professor
Department of Respiratory Medicine
Erasmus MC
www.ipfonline.nl



Genomic medicine approaches – two contrasting case studies

Cecilia Van Cauwenberghe from Frost & Sullivan's TechVision Group Genomic medicine approaches – two contrasting case studies to note including the overall perspective, as well as the challenges and concerns in the field

Genomic research, particularly genome sequencing, has dramatically been translated into clinical practice. This fact is also demonstrated through the strong government financial support evidenced in the implementation of genomic research into healthcare systems. Numerous national genomic medicine initiatives are presently active, unparalleled propelling transformational healthcare (Stark et al., 2019). However, ethics may present some highlights around genomic medicine. Here, two extreme case studies are unveiled: Finland and China. How countries are evolving their medical systems through genomic medicine approaches?

Case Study #1: Finland

As many other developed countries, Finland is strongly betting to the opportunities generated by the availability of huge amounts of data and gene based collections. Big data is expected to actively participate in the enhancement of medical research and the consequent generation of economic wealth, in the path toward the total access of the population to health and wellbeing. The imperative relies on the usage of massive genomic data justified by the moral principle of improving health (Snell, 2019).

Such imperative of health also establishes the legal regulation of data collection, infrastructure development and genomic innovation. Finnish data-driven medicine is based on the moral principle of health, with policies related to privacy and autonomy subjected to this national goal. On that note, the highly restrictive and conscious government regulatory policies of data privacy and security become the major challenge for leveraging the entire potential of big data analytics in the country. However, Finland has found a potential solution through the institutionalisation of automatic systemic data anonymisation policies in order to make healthcare data safe from cyber-attacks and accessible to life scientists (Taiwo, 2019).

Case Study #2: China

At the opposite corner, violating the ethical consensus of scientists all over the world, a team of Chinese scientists led by He Jiankui. He presented during the second World Summit of Human Gene Editing in early 2019, the gene-editing project that led to the birth of two baby girls with man-made C-C chemokine receptor type 5 (CCR5) mutations. This research was strongly repudiated by the worldwide scientific community as an extremely irresponsible behaviour that exhibits a lack of both medical ethics and understanding of gene editing science. The gene editing on a human germline constitutes a severe violation of both the Chinese regulations and the consensus reached by the international science community (Wang and Yang, 2019). However, this incident triggered a wide-ranging discussion about the criteria and standards for genome editing in the human germline for reproductive purposes, attempting to reach a solid consensus about clear and strict policies at an international level.

> "Genomic research, particularly genome sequencing, has dramatically been translated into clinical practice. This fact is also demonstrated through the strong government financial support evidenced in the implementation of genomic research into healthcare systems."

It is remarkable to highlight that the present gene editing technologies that attempt to introduce precise genetic modifications into the human germlines are still poorly developed. Although a further development and improvement of these technologies may provide solutions for many genetic and rare diseases, presently severely underserved by medical therapies, a regulatory framework is needed before translating gene editing solutions from genomic research to specific medical applications (Ye et al., 2019).

Final remarks

In contrast to the Finland case, where a national commitment governs the most critical decisions regarding health and wellbeing actions, there is a serious lack of awareness about the importance of ethics in China. Some researchers emphasise on the urgent need to improve both ethics training and scientific knowledge. In fact, present members of ethics committees are considered by the international scientific and clinical community as probably not well positioned to assess emerging technologies rigorously (Lei et al., 2019). ■

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Cecilia Van Cauwenberghe, PhD, MSc, BA
Associate Fellow and Senior Industry Analyst
TechVision Group, Frost & Sullivan
cecilia.vancauwenberghe@frost.com
ww2.frost.com
www.twitter.com/Frost_Sullivan

Finland: A framework for genetic research

Mark Daly, Director of the Institute for Molecular Medicine Finland (FIMM), HiLIFE at the University of Helsinki, shares his expertise on medical genetic research on a population scale in Finland

Long before the completion of the Human Genome Project, the promise that genetic research would uncover critical insights about the origins of disease that could lead to new and more effective therapies has been within sight, but not within reach. Very promising examples of targeted therapeutics against specific cancers and novel lipid-lowering medications have emerged but the road from genome to disease insight to therapy has been more challenging than some had hoped.

It has become clear that many key medical insights require the integration of an enormous scale of genetic and medical information from 100,000s to 1,000,000s of humans in order to be discovered – yet in most parts of the world, the collection, aggregation and integration of such information has been precluded by many logistical and regulatory hurdles. Inherent to the problem is the challenge in striking the right balance between individual data protection and autonomy and the scientific progress that is possible only when data from many individuals is assembled and studied.

An individual's medical data is clearly one of the most private elements of personal data and must always be given the highest level of data protection and to be in the control of the individual. This is, of course, a primary goal of the GDPR, as well as regulatory frameworks in other parts of the world. At the same time, as medical and genome sciences have advanced (and we have learned the value of their integration), providing access to these data on a large-scale to promote research discovery is seen as an opposing pressure. Indeed, critical insights relevant to both individual diagnoses and therapies in rare diseases and cancers, as well as the discovery of therapeutically actionable biology in common disease are now possible but often require genomes and health data from extremely large samples to be analysed together. How to ethically balance data protection and promote essential medical discoveries and innovation is, therefore, one of the major challenges in research medicine today.

Finland tackled this challenge proactively and efficiently with an innovative national Biobank Act in 2013. While completely protecting individual data (consistent with the later GDPR requirements), the Biobank Act facilitates responsible and approved medical research in academia or industry with several critical elements. First, is the introduction of the concept that individuals may provide a 'broad consent' for approved medical research (and, therefore, need not consent to each separate approved research project individually). Second, a straightforward way in which previously collected samples (such as valuable epidemiological collections with extensive characterisation and longitudinal follow-up) can be transferred to the national biobank framework and used in future studies. Third, individuals consenting to join the biobank can be recontacted (based on their medical and genome data results) in the context of an approved research study, creating the opportunity to build a dynamic research resource that can be updated with not only national health registry data but individuals are invited to participate in secondary research studies. Equally important are provisions that individuals may remove consent at any time and request any data generated on their samples or data. Such a forward-looking framework has resulted in the initiation of large-scale and innovative research projects, such as FinnGen.

The FinnGen project aims to collect genome data and integrate it with national health registry information on 500,000 Finns (almost 10% of the population). FinnGen is supported by a unique public-private partnership involving the Finnish government innovation fund Business Finland and a consortium of nine pharmaceutical companies. Made possible by the progressive Biobank Act, the study has a focus on generating therapeutically relevant insights surrounding the root causes of common diseases, as well

as their progression and responses to therapy. The project will, therefore, utilise both deeply studied legacy collections, the subjects of which in many cases are quite old and newly recruited patients from hospital clinics throughout Finland (more than 150,000 individuals in less than two years).

With all individuals recruited into the Finnish biobanks, the project is then approved to perform a broad set of analyses including (from the approved study plan) the "identification of deleterious predisposing and protective disease variants, the development and genetic exploration of novel longitudinal disease progression and response phenotypes and the use of genetic information for prioritising potential drug targets". That such analysis can be done in an ethically responsible way, with no individually identifiable data in the hands of research staff outside the approved government agencies which handle such data, is a credit to the innovative spirit in Finland and, in particular, the commitment of a population who see the benefit of an advanced medical system comes with a responsibility to permit their data to be used in further critical medical research.

While Finland is making progress, we must distribute lessons learned and technology platforms to ensure global progress. Mechanisms for sharing personal data appropriately and anonymously across national boundaries, not just within, must be developed since human biology and medical challenges are shared by all and efforts, resources and samples in any one country are insufficient to solve the most complex medical problems. Moreover, since medical (and particularly genomic) research has been very disproportionately centred on people of European ancestry, it is ethically imperative that locally appropriate and secure genetic data sharing techniques be adopted widely in Asia and Africa, as well as Europe and North America.

Furthermore, we must accomplish this in a way that respects cultural differences and recognises the importance of capacity and infrastructure building in under-resourced locations. Only then will we ensure maximum value is achieved from existing, as well as newly developed medical research efforts around the world. In this way, we may finally deliver on the promise of the Human Genome Project, ensuring that the fruits of medical genetics research can inform on the biology of disease in all people and lead to a new era of improved therapeutics for all.

FIMM

Mark Daly
Director
Institute for Molecular Medicine Finland (FIMM), HiLIFE, University of Helsinki
Tel: +358 50 546 8790
fimm-director@helsinki.fi
www.fimm.fi
www.twitter.com/dalygene
www.twitter.com/FIMM_UH

NHS: Why AI investment is just one piece of the puzzle

The news that the UK Government is investing in artificial intelligence is hugely welcome, but to truly reap the benefits, AI must be part of a wider scheme of data utilisation, digital process automation and citizen engagement. Peter Ford, Public Sector Industry Principal, Pegasystems tells us more

On 8th August 2019, Health Secretary Matt Hancock allocated an additional £250 million to be invested in an artificial intelligence (AI) laboratory that will lead to a better ability to screen for cancer, identify patients most at risk of diseases such as heart disease or dementia, build systems to detect people at risk of post-operative infections and more.

On the face of it, this announcement looks like very good news. Hancock commented: "We are on the cusp of a huge health tech revolution that could transform patient experience by making the NHS a truly predictive, preventive and personalised health and care service." He also emphasised his determination to: "bring the benefits of technology to patients and staff, so the impact of our NHS Long Term Plan and this immediate, multimillion-pound cash injection are felt by all."

Whilst some examples of the potential uses of AI have been given both in administrative and clinical contexts (which also include predicting patients most likely not to show for appointment and inspecting existing algorithms already used by the NHS to ensure patient confidentiality is protected), there are many other examples of applications of AI to support patient care. For example, the monitoring of Type 1 diabetic patients and of those that have heart conditions via body-worn devices can bring about transformational improvements in the individual's health and also reductions in the cost to the taxpayer.

With higher patient expectations and increases in life expectancy, a growing number of citizens require pre-emptive advice to promote better health. Leveraging the insight trapped in the UK population's medical data can make the difference. But with more data and complexity than ever, unlocking this insight is becoming increasingly difficult. Consequently, opportunities for preventive measures and the most efficient corrective care are not always being taken.

So how could AI in collaboration with other technologies improve the NHS?

AI with end-to-end process automation to improve preventative healthcare

As life expectancy rises and pressure on NHS resources grows, investing in ways to educate citizens with pre-emptive advice to staying healthy is growing in importance. To succeed, businesses need an easy, accurate and reliable way to create and incorporate predictive analytics and decisions into every process and interaction. Coupled with other leading technologies, such as interactive business process management, robotic automation and context-sensitive transparent guidance and decisioning, AI should bring about both improvements in patient care at the same time as similar enhancements in operational efficiency.

AI with analytics to make cost savings and improve efficiencies

The use of AI and analytics can inform on trends on overtime and temporary staff working patterns, plus identification of likely increases in demand to help set the right numbers of doctors and nurses along with other infrastructure provision. Integration of data from different sources within the NHS and agencies outside of it could also inform where different supply options for beds provide the best value for money.

AI with external source data to inform policy

AI could be used to bring together disparate data sources to indicate the best options for how to improve patient care. For example, with sufficient online information to notify on likely shortfalls in public sector rehabilitation beds, private-sector resources could be taken advantage of more to take the strain of the public-sector. The NHS could analyse the particular needs of a patient based on case history, clinical guidance and rules with AI to decide on the best course of action.

> "On 8th August 2019, Health Secretary Matt Hancock allocated an additional £250 million to be invested in an artificial intelligence (AI) laboratory that will lead to a better ability to screen for cancer, identify patients most at risk of diseases such as heart disease or dementia, build systems to detect people at risk of post-operative infections and more."

Furthermore, data from social welfare can be used to inform policy at both a macro and local level, as healthcare and social welfare are so inextricably linked – what happens in one domain often gives rise to demands on the other. The delivery of social welfare by local government versus centralised provision of healthcare has previously caused issues, so orchestration of inter-agency sharing of information is imperative.

The government says AI is already being developed in some hospitals, successfully predicting cancer survival rates and cutting the number of missed appointments. It is motivating that this technology is already saving lives, however, it is clear AI alone will not result in the desired outcomes. It needs to be part of the greater plan by also taking into account technologies such as digital process automation, smart use of data and a focus on patients to ensure this investment delivers on its promises. ■

Peter Ford
Pegasystems
www.pega.com
www.twitter.com/pega

Leading digital change with WellSky EPMA

Of all of the digitisation projects currently underway at St Helens and Knowsley Teaching Hospitals (STHK) NHS Trust, electronic prescribing and medicines administration (EPMA) represents the biggest step forward for patient safety, ensuring the right drugs get to the right patient at the right time

When it comes to reducing prescription errors, a recent study by the universities of York, Manchester and Sheffield reported that in England's NHS alone some 237 million medication errors occur every year, which, as former Health Secretary Jeremy Hunt estimated, accounts for between four and five deaths a day. Whilst the NHS is committed to reducing these errors by 50%, St Helens & Knowsley working with WellSky International (formerly known as JAC) have challenged themselves to achieve an even higher rate.

In April 2017, Whiston, an in-patient hospital, went live with WellSky's web-based EPMA. In under a year, the Trust saw positive results by digitising medicines management.

The system links with WellSky Pharmacy stock control module and together create an end-to-end integrated medicines management platform that can interface with their System C Patient Administration System for order communications, admissions/discharge and other functionality. This digital environment enables quick and easy data sharing across wards and other trust sites, providing nurses and doctors with secure access to patient records even while they are on the road.

Why WellSky? In addition to already having its pharmacy stock control system, the Trust wanted an electronic prescribing solution with broad functionality, designed by domain specialists and already with a proven user base. At the time of selection, the Trust didn't have an electronic patient record (EPR) so were free to choose the EPMA market leader.

One of the main priorities was a modern web-based system that was intuitive to use for mobile clinicians and would be easy to deploy, upgrade and interface with other applications as our digitisation programme evolves. EPMA's web version updates are done directly from the IT centre with users accessing the system via URLs. Not only does this save a great deal of time, but it also ensures everyone is always using the same version.

The digital transformation

"The new system is much more efficient and quicker than other versions that I've used previously," said Dr Andrew Hill, Clinical Lead for Stroke Services.

When WellSky EPMA was introduced to clinicians, the web interface – which was designed following in-depth study of how users navigate screens – greatly simplified the training process.

In fact, the speed with which the Trust overcame cultural and technology barriers were especially impressive considering the complexity of electronic prescribing. There is a vast array of medicines, protocols and dose bandings to be custom configured into the drug database, along with exception alerts for the drug allergies and the special sensitivities of individual patients. Given that a single error can be life-threatening,

Image: © Syda Productions | Dreamstime.com

this explains why medicines management has one of the lowest tolerances to error: It simply must be safe.

Eliminating transcription mistakes

"On electronic systems, you reduce the amount of hand-written transcription of medications; which significantly reduces the number of prescribing errors," commented Dr Andrew Hill, Clinical Lead for Stroke Services.

Like all hospitals, the Trust used to have problems with the wrong medicines being delivered to the wards because of the order's illegible handwriting. And while these were always spotted in time, it posed unnecessary risks. WellSky EPMA eliminates this risk.

Other safety features include decision support tools like best practice medicines and dosage defaults. By prescribing electronically, orders no longer go astray and drug administering schedules can be monitored and flagged up if a round is missed. And in cases when care is time-critical, a change in prescription or dosage can be reviewed and amended remotely in real-time. The Trust has noted a marked reduction in medicine incidents logged by the Datix incident reporting system.

Saving clinician time

With WellSky EPMA clinicians no longer wade through old kardexes to look up a patient's medication history. Instead, doctors can see a patient's complete real-time prescription sheet on a single consolidated screen; determine when a particular drug was last administered and find out why it was stopped. Because all medicines data is captured within the database, on readmission to the hospital a patient's treatment history can be called up instantly. The pharmacy/treatment dispense information interface allows EPMA data to be downloaded to create discharge letters for the patient's GP.

Digitising the Trust's medicines management environment has also had a positive impact on operational and financial efficiencies. The wealth of data captured by the WellSky EPMA system is not only clinically rich but enables the generation of a wide range of reports and analysis of both clinical and operational outcomes in a way previously not possible. With future EPMA rollouts planned for St Helens Hospital, outpatients and possible outreach into community hospitals, the project is nothing short of transformative.

WellSky

Cathy Young
Marketing Manager
WellSky International Ltd
Tel: +44 (0)7909 226 215
cathy.young@wellsky.com
www.wellsky.org
www.twitter.com/WellSkyIntl

New SBS Framework: Audio Visual Solutions and Integrated Operating Theatres

Here, we find out about the highest-scoring supplier – Jones AV Ltd, who discuss the New SBS Framework: Audio Visual Solutions and Integrated Operating Theatres

With the new "integrated operating theatre" framework from NHS-SBS, some new players are entering the UK Market, to bring change, technical innovation and value for money to theatre integration projects in the NHS.

Jones AV has been delivering the highest calibre, internationally acclaimed and award-winning Operating Theatre AV integrations for the past ten years.

The company counts some of the most renown universities and hospitals all across Europe and an illustrious selection of the biggest names in the medical arena as their clients.

Even though based in the UK, the company has held back entering the UK market directly until relatively recently. "It was a conscious decision to wait until the market was ready, in terms of technology, demand and the right route to market," according to their MD Ingo Aicher.

With just over two years of activity in the UK, the company has built up an impressive roster of UK private clients and some flagship NHS projects. Such as the recently opened new Royal Papworth Hospital and the new Edinburgh Hospital for Sick Children, the new Royal Liverpool to name but a few.

For Jones AV, the key for delivering the highest quality systems is not only in the choice of products but also in the system infrastructure and architecture.

"We have delivered complex HDSDI systems before they became industry standard and have been early adopters in uncompressed video over IP solutions. Not merely are all our current systems fully 4K capable but already 8K ready."

St. Olav Hospital Robotic Theatre 2009

The company has longstanding experience in Norway. A country with an early adopter mindset for all things technology, which proved to be an ideal platform to develop new systems and solutions, ahead of the curve. This manifested itself with the company winning the coveted InAVation award for the world's best Healthcare AV solution for four years running.

Within every project, it is Jones AV's aim to deliver the highest-quality build whilst providing 100% of customer-defined functionality. Each system is future-proofed with added capacity for expansion and the latest technology available for the best image quality possible. Coupled with customisable, intuitive and easy to use control interfaces, this guarantees the best possible personalised workflow in the operating theatre.

The combination of technically advanced and future-proof designs with our comprehensive preventative maintenance and service, results in the very unique fact that every single system delivered since 2008 is still in full 24/7 operation.

The company has multilingual personnel trained to the highest standards. Not

New Royal Papworth Hospital Cardio theatre 2019

merely in AV, fibre optics, system integrations, adherence to strict standards such as IEC 60601-3, but also in clean room conditions, infection control, health and safety, broadcast standards, computer networking, project management and so much more.

The NHS SBS framework offers a fantastic vehicle for NHS trusts, to access pre-approved suppliers for direct award for smaller projects and at the same time trusts can satisfy their internal statutory demands by running mini-competitions.

Amongst all the participating companies, Jones AV stood out particularly for its value for money, high-quality products and quality of service. For your added peace of mind, Jones AV is the only specialist company with quality assurance certification for ISO 9001:2015 and 14001:2015 for the Design, implementation and integration of Medical Audio Visual Systems.

Besides integrated theatres, the framework also covers Multi-Disciplinary team rooms and associated AV solutions. So no matter if you are looking to optimise your theatre workflow, have more efficient team meetings, superior student training or better remote connectivity for telehealth services, talk to the frameworks highest-scoring supplier for service, quality and price.

To register for the framework and find out more, go to https://www.sbs.nhs.uk/proc-framework-agreements-support and enter the Framework Reference: SBS/18/CR/WCN/9343

Or contact Jones AV directly on +44 (0)151 675 0675 or info@jonesav.info, to find out more.

Jones AV Ltd.

Ingo Aicher
Managing Director
Jones AV Ltd.
Tel: +44 (0)151 675 0675
info@jonesav.info
jonesav.net

Could technology help break down barriers to patient flow in the healthcare system?

Neil Laycock, Managing Director of Healthcare, Servelec, explores the potential for digital solutions to change the narrative on managing precious assets in the healthcare environment

The significant challenges facing the UK's treasured NHS playing out against the headwinds of a turbulent political backdrop are making solutions hard to come by. Most NHS trusts in the UK, for example, have been facing critical bed shortages for years, and yet management of those scarce assets continues to be a complex, complicated and heavily contested process. At the heart of it, all are the patients, whose care is being profoundly impacted up and down the country every day. Few could argue with the need for fundamental change.

The newly launched NHSX promises just that. With its mission to take forward digital transformation in the NHS, allowing patients and staff to benefit from the latest digital systems and technology, it aims to create a revolution in how care is delivered. It is further bolstered by the Chancellor's recent spending review which assures renewed focus and funds for the health and social care sector: £6.2 billion in the 2020/21 financial year.

We know the answer doesn't necessarily lie in (more) beds, and certainly not with rushing people out of hospital for the issue to then manifest itself in another part of the system. So what can innovators do to help ease the pain points of a system conceived before technology could offer a better way? Is it possible to retrofit technology to address asset management in healthcare?

Why asset management matters

With the NHS so stretched and operating at or over-capacity, optimising the use of physical healthcare resources such as beds is central to successfully managing patient flow. Using NHS resources more effectively so they reach their full potential means clinicians are freed up to focus on those in their care rather than consumed by asset management – making patients the top priority as should absolutely be the case.

The consequences otherwise are far-reaching. Whilst the crisis around the availability of beds in emergency wards is widely reported and naturally concerning, the issue is, in fact, felt at every touchpoint in the health and social care system, with professionals facing constant barriers to transitioning patients through it.

> "Digital solutions which enable better asset management free up valuable clinician time and provide staff with accurate information at their fingertips."

Paper-based processes and the use of whiteboards to organise and map beds is inefficient and inaccurate. Entrenched ways of working differ from ward to ward meaning communication can fall down; time and resource that could be better spent on patients are consumed in bed meetings, trying to chase down capacity with an incomplete picture.

These silos of information prohibit not just a joined-up view of the system's bed inventory, but even more concerning of the patient themselves – the impact of which is potentially devastating. A piece of paper lost, information scrubbed from a whiteboard could lead to something important being missed, increasing the chance of clinical risk. Duplicative data entry is commonplace as staff attempt to make sense of ward capacity; this can lead to inconsistencies in patient records alongside the obvious data protection concerns. All of this puts more pressure on staff and takes their time away from patients.

Free-flowing data make patient care safer

The professionals I encounter universally agree that the solution lies at the intersection between the

Neil Laycock, Managing Director of Healthcare, Servelec

physical and the digital – with improved access to real-time bed information and associated clinical and operational tasks which supports the management of actual patient flow within the hospital through to discharge. What is required is a fundamental shift in the approach towards how beds are managed, using key predictors to inform flow.

Intuitive end-to-end solutions which document the patient's first presentation through to discharge and can be integrated into existing Electronic Patient Record (EPR) systems and patient administration systems and give hospital staff the up-to-the-minute data they need to make informed decisions. Invaluable electronic dashboards can accurately display capacity information at site, ward and bed level at a glance means operational and clinical tasks can be expedited and patients moved along their care pathways.

The scale of the challenge is perhaps daunting but far from insurmountable; on the contrary, the health and social care system has already come a long way and proven it is adept at adopting new technologies – using instant messaging to communicate on the go and the success of EPR systems.

Digital solutions which enable better asset management free up valuable clinician time and provide staff with accurate information at their fingertips. Technology can underpin a 'right bed at the right time' approach – helping staff make better-informed decisions which reduce the length of stay, improve the quality of care and overall patient experience. Trusts have a great opportunity to adopt interoperable best of breed systems. The next step is to embrace interoperability across the full health and social care picture – working towards a future where the patient journey is seamless and truly centred on them. ■

Neil Laycock
Managing Director, Healthcare
Servelec
Neil.laycock@servelec.co.uk
www.servelec.co.uk
www.twitter.com/Servelec_

Innovative bed tracking at a Northern Health and Social Care Trust

Brendan Crossey, Chief Executive Officer of Healthcare Analytics Limited, directs our thoughts to innovative bed tracking at the Northern Health and Social Care Trust, one of five health and social care trusts in Northern Ireland

The Northern Health and Social Care Trust (NHSCT) is one of five health and social care trusts in Northern Ireland. They provide a comprehensive range of health and social care services to a population of almost 471,000 people across a geographical area of 1,733 square miles, making it the largest geographical trust in Northern Ireland.

The Trust has a budget of £687 million and employs 11,800 staff across a full range of medical, health and social care disciplines.

The Trust delivers services from over 150 facilities including two major general hospital sites, a mental health hospital, local community hospitals, health centres, social services and a significant network of community services, as well as provision of care in the home.

The Trust provides emergency hospital services on two sites, Antrim Area Hospital and Causeway Hospital in Coleraine.

The need

The Trust required the ability to know the location of every medical bed and associated mobile medical devices in their hospitals. The clinical and medical engineering teams faced a daily battle to locate beds and mattresses, as they are frequently underutilised and poorly maintained. This created a risk burden and a significant yet avoidable cost. This led to compromises in relation to time, cost efficiency, safety, patient care and risk management.

They estimated that nursing staff were spending on average 21 minutes on every shift looking for equipment. The staff did not have access to all the required information to ensure that every patient was able to be provided with the right bed for their individual situation e.g. bariatric to reduce bed sores or other complications.

The estates team estimated that they were purchasing 25% more equipment than actually required for operational needs.

In brief, they wanted a real-time asset location service that would start with beds but could be scaled up to manage all mobile assets, the service would require an integrated task management application for monitoring the location, cleaning, calibration and maintenance of these assets.

The solution

To provide this capability, Healthcare Analytics and our partner Multitone Electronics engaged in a research project with the Medicines Optimisation Innovation Centre (MOIC), an innovation unit within the Northern Ireland Health Service to build the i-trackbeds service.

The solution comprises of a small chip and antenna, RFID tags are attached to beds and mattresses. Each tag has a unique device identification number and uses radio waves to identify and track beds and mattresses.

A barcode is included on all tags to allow staff to integrate the history of a device by scanning its barcode using the mobile app. The mobile app also allows staff to manage requests for bed moves, cleaning and maintenance. All requests, notices and alerts are processed via the Multitone mission critical iMessage Service which guarantees that all messages are sent and received in a timely manner.

The whole service is managed via a Management Dashboard which includes the database and software for processing the data.

The result

Over the last three months, the movement of medical beds has been successfully tracked in Antrim Area Hospital and staff are now able to know exactly the location of each bed in the hospital.

The i-trackbeds solution helps staff in Antrim to ensure security and regulation compliance, as well as enabling employees to work more efficiently on a daily basis by solving the issues around the location and management of beds and mattresses.

In addition, they have found that improved device management, availability and utilisation reduces the need to loan beds and mattresses to accommodate short-term demand.

In future the process of bed and mattress rentals will be automated with nursing staff able to raise requests for rentals, which are sent for approval, with a reminder raised at the end of the period and rental companies automatically informed of the return with its location.

What's more, significant rental charges can be avoided by ensuring clinical staff only use specialist beds and mattresses when necessary.

"Our PATIENTS get access to the RIGHT equipment at the RIGHT time for the RIGHT patient – resulting in safer patient care while delivering a better patient experience" Dr Naomi Baldwin PhD, Senior Nurse Patient Safety and Performance, Northern Health and Social Care Trust.

What next?

The Trust is now looking at expanding the use of this service to all mobile devices across the trust. The Trust will also be exploring the use of the service to enhance the safety of vulnerable patients. As an integrated care provider, the trust is looking at using the service to provide connected medical devices to monitor the care of patients in the community.

"Our PATIENTS get access to the RIGHT equipment at the RIGHT time for the RIGHT patient – resulting in safer patient care while delivering a better patient experience."

The platform can now support the management of assets which could be beds, mobile devices, staff or patients internally in the hospital or out in the community, as the system has the ability to utilise both active or passive tags using any or a mixture of the major connectivity protocols i.e. Ethernet, 4G/5G, Bluetooth BLE, Wi-Fi, RFID, LoRA or Sigfox IoT Networks.

HEALTHCARE ANALYTICS

Brendan Crossey
Chief Executive Officer
Healthcare Analytics Limited
Tel: +44 (0)2838 442 081
brendan@healthcareinsafehands.com
www.healthcareinsafehands.com
www.twitter.com/safehands_uk

Precision medicine: Cost-effectiveness of breakthrough treatments

Dr Gerry Morrow shares his thoughts on the precision medicine, defined as the cost-effectiveness of breakthrough treatments and explains why this area is a priority for both researchers and government

The emergence of precision medicine is upon us. Defined as an approach to patients with specific and identifiable characteristics, which enable a targeted diagnostic or treatment methodology. It has become a priority focus for both researchers and the government.

Within this broader category of precision medicine, there are two defined subcategories, which are precision targeting and breakthrough precision medicine. The distinction between these two categories is critical to their cost-effectiveness and the likely usage of such tests or therapies. (1)

Precision targeting

Precision targeting or stratified medicine describes a process of narrowing the use of conventional medicines and diagnostics based on using information such as pharmacogenomics, medical records and demography.

This process is predicated on three elements. Which are:

1. Effective genetic tests to diagnose illnesses reliably and early;

2. Companion diagnostics or biomarkers which deliver sensitive and specific results and;

3. Informatics or the analysis of large data sets collected from patients and/or a wider population.

The expectation is that the precision targeting approach will provide clinicians with the diagnostic tools and therapies to prescribe the "right treatment to the right patient while simultaneously reducing waste and yielding cost savings." (2)

These cost-savings have not yet been realised across all disease areas. The reasons for this are multiple but relate chiefly to the fact that development costs are still being incurred. However, the system sounds biologically plausible when one considers the potential of fewer inappropriate investigations, reduced iatrogenic problems or unplanned admissions and improved potential outcomes for patients.

"Precision targeting or stratified medicine describes a process of narrowing the use of conventional medicines and diagnostics based on using information such as pharmacogenomics, medical records and demography."

Breakthrough precision medicine

The second type of precision medicine, 'breakthrough precision medicine', derives from the development of fully personalised curative drugs; in particular, genetic and regenerative cell therapies, which it is anticipated will be tailored specifically to each patient's genomics and disease features.

The key considerations in this category of innovation are the likely enormous costs of drug development against the therapeutic value for a patient who goes on to have a full and productive life.

Adding to the economic considerations, we should be aware of the influence of the burden of illness and the social impact involved in the potential of using a pooled national financial resource for expensive treatments for individuals with rare diseases.

This has been highlighted recently in the case of a dispute relating to the cost of a drug for cystic fibrosis.(3) This new therapy which is said to improve the lives of

affected patients has fallen foul of NHS England pricing arrangements. Even though this is a conventional medication which has not yet reached the precision medicine category.

Additionally, in the UK we are nationally constrained by the NICE 'value-based assessment' of health technologies, which places a standard financial threshold on the incremental cost-effectiveness ration (ICER) per quality-adjusted life year (QALY) of up to £30,000.

Having said this, NICE has revised their financial methodology for end of life technologies, where the ICER per QALY has been revised upwards to £50,000 and for very rare diseases, where the ICER per QALY has been increased to a £300,000 maximum. [4]

There have been criticisms of the NICE methodology, with researchers commenting that despite their transparent procedures it mitigates against expensive innovation and can result in 'different values being placed on health gains for identical patients' [5]. Ultimately this may lead to a lack of access for patients who rely on the NHS. This could result in a situation where the much-touted democratisation of precision health, based on harvested population data, may end up benefitting only those with sufficient means to fund individual clinical trials, research and personal drug manufacture.

It is uncertain 'how' or indeed 'if' NICE will revise their value-based assessment approach to deal with these nascent technological advances that comprise precision medicine.

Conclusion

'Precision targeting' seems unarguable and feels like a direct continuation of the evidence-based medicine approach for all clinical practice. Over the next five to ten years it is likely that we will investigate and treat patients according to their defined genotype and phenotype.

'Breakthrough precision medicine' sounds tantalising to the patient and to the clinician. A 'golden bullet' approach to a disease entity unique to each patient seems to move us closer to a science fiction future of healthcare. But, just as this appears fantastical, the costs may also be fantastically out of reach for most patients.

As usual, science is moving faster than ethics. Our challenge, therefore, is to find a way to harness this new technology whilst retaining the benefits for even the most vulnerable in society. ■

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Dr Gerry Morrow
Medical Director
Clarity Informatics
Tel: +44 (0)845 113 1000
www.clarity.co.uk
www.linkedin.com/in/gerrymorrow
www.twitter.com/Clarity_hi
www.twitter.com/Clarity_Gerry

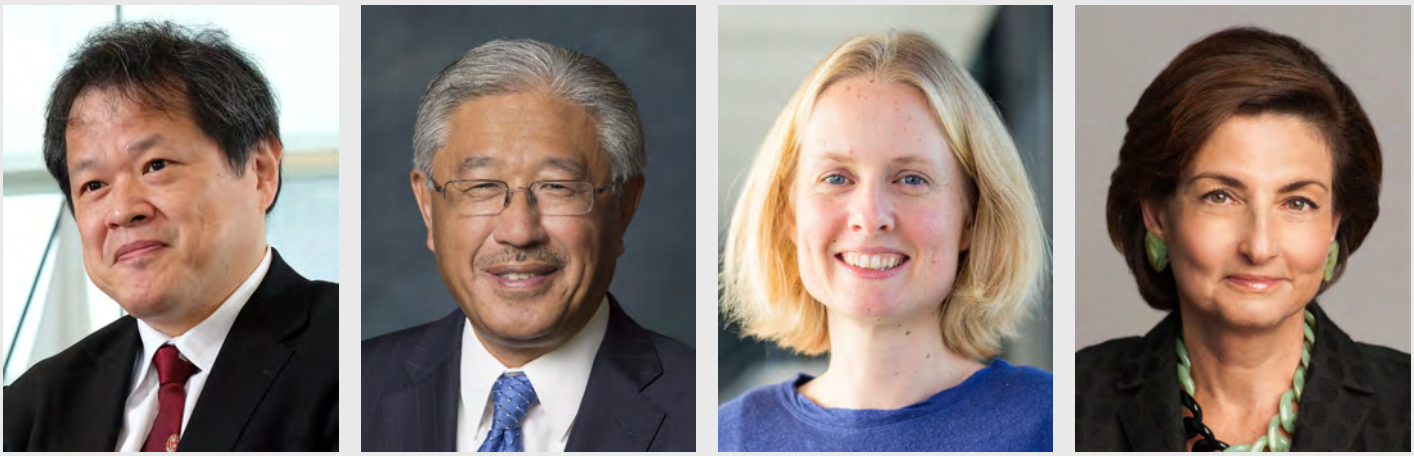
Data linkage and sharing for healthy longevity: A global challenge

Data linkage and sharing for healthy longevity together present a global challenge, in the view of Prof Makoto Suematsu and Prof Victor J Dzau, Co-chairs of Global Future Council for Human Enhancement and Longevity at the World Economic Forum

Data sharing in medicine is easier said than done. Of particular importance is data sharing across national borders. The evolution of deep space science resulted from global data sharing that helps researchers discover blackholes using hundreds of radio-telescopes set up all over the world. In medicine, on a positive note, infectious disease research initiatives including Global Research Collaboration for Infectious Disease Preparedness (GLOPID-R) and Infectious Disease Data Observatory (IDDO) are advocating for global data sharing to improve diagnosis and treatment of patients and to ensure coordinated and effective responses to emerging infections and cross-border threats to health.[1] The International Rare Diseases Research Consortium (IRDiRC) found that nearly 80% of rare disease researchers who responded to its survey had experience of sharing data internationally. Why are successful examples so rare in medicine? Reasons include intra- and extra-territorial factors; coordination failure among different ministries responsible for health care and medicine under heavy bureaucracy, siloed systems of electronic health records within individual nations, conflicts and competition for medical research resources among individual researchers and industrial sectors all over the world, etc. In these circumstances, how can we utilise global data sharing to fast-track medical R&D and achieve healthy longevity all over the world?

Super-ageing is one of the biggest issues for global health which, sooner or later, most of countries will experience. As predicted previously[2], the competition for resources dictated by free-market principles will be the undoing of the medical commons. Sooner or later, most of countries will need to adopt global mechanisms to foster innovative ideas raised by young investigators and to catalyse them within the private sectors and to share challenging experiences between preceding super-ageing nations and younger nations. We cannot otherwise guarantee sustainability.

An area of global importance is the ageing of the population. It is predicted that by 2050, 1.6 billion or 18% of the world's population will be over 60 years old. This is associated with a global decrease in fertility rates. In Japan, around the time of the Meiji Restoration (1868), only 20% of Japan's population was over 50 years old and that percentage remained more or less unchanged until the 1970s. The Japanese population started to age rapidly around then, however, introducing universal health coverage, the eradication of major infectious diseases and rapid economic growth had the combined effect of increasing life expectancy and reducing fertility rates inexorably. Japan has, thus, now become a super-aged society and the trend is continuing: By the 2040s, an unprecedented ultra-super-ageing demographic drift will reach its peak with only 35% of the population being under 50 according to the prediction by Dr Toshihiko Hasegawa. In 2019, now that this great population shift has already advanced two-thirds of the way through this great transition phase, Japan has only two decades in which to find effective solutions to ensure healthy longevity by the time it reaches the ageing peak. It should be noted that developing the drugs and medical devices needed for any such solutions takes time. If we consider the likelihood that many other countries will also begin to age rapidly in the next few decades, global sharing of data and values on comprehensive medical/environmental/social studies for healthy longevity are indispensable to achieving sustainability



Authors (Left to right) Makoto Suematsu (Co-chair), Victor J Dzau (Co-chair), Janneke Annegarn and Linda P Fried

of human health. A good practice to follow in the global sharing of data would be the Alzheimer's Disease Neuroimaging Initiative (ADNI) project[3], which has strict rules designed to encourage sharing of collected data among its members including both public and private research institutions.

The super-ageing of populations might serve as a huge opportunity to promote a so-called silver market for human wellness. At the meeting of the Global Future Council (GFC) on Human Enhancement and Longevity held in Dubai during November 2018, the Council organised the four workstreams for healthy longevity researches: "Understanding needs of the elderly to fully leverage the opportunities of the silver market", "Ethics, equity and governance of an ageing world population", "Appreciating the human capital of older adults and developing human capital for the care of older adults" and "Global data sharing". Countries offering public funding to R&D projects on healthy longevity should make it a condition that the resulting data be shared internationally after an appropriate waiting period. Such discussion was further galvanised at the Davos-Kloster meeting in January 2019, as exemplified by Prime Minister Abe's speech proposing "Data Free-Flow with Trust" for medical and industrial R&D purposes, while the privacy of the individuals' health data should be sufficiently secured.

Data linkage and sharing among different health care stakeholders may provide numerous benefits for healthy longevity. The decline in the physical functions of the elderly patients is not steady but staggered and is typically precipitated by hospitalisation for acute diseases. Accumulating clinical data on ageing patients with acute illness can facilitate more detailed monitoring of this trend and help to optimise medical care services. Nursing care for the elderly is another area that could benefit from data sharing. One promising approach in this regard is human enhancement using biomedical technologies to augment the physical/mental capabilities and health of those that are weakened with age. Some human enhancement technologies have widely been adopted, including interocular cataract lens (IOL) implants, bipolar hip arthroplasty (BHA) for osteoarthritis and pacemaker implantation for heart failure patients. The development of more ambitious enhancement technologies will require the comprehensive use of new materials, robotics, artificial intelligence (AI) and nanotechnology and among others, together with the continued collection and analysis of clinical data for fast-tracking next-generation silver R&D.

Unlike established medical procedures to treat diseases and restore mental and physical functions which are approved following clinical trials with middle-aged participants, further application of human enhancement technologies for the overall improvement of health and well-being for the elderly will require careful consideration of many issues. Human enhancement technologies that are physically and/or psychologically invasive must be demonstrably safe to use for the elderly, just like any medical procedures. Invasive human enhancement technologies are ultimately a means to complement the users' physical and/or mental functions and to improve their health. A survey by the American Association of Retired Persons (AARP) on the application of human enhancement technologies revealed that of approximately 2,000 adult respondents, over 90% supported

the use of the technologies to regain normal physical and mental functions, including sight recovery and joint replacement. However, the respondents did not approve of applying the technologies to acquire exceptional or superhuman abilities, such as sharper cognition (memory) or increased muscular strength.[4] As this survey demonstrates, there is a public awareness that human enhancement technologies have the potential to allow us to overstep our limitations, which could change the very foundation of society and humanity as we conventionally see them. Such adaptation and tolerance levels might differ among different countries with different cultural backgrounds.

"The number of Alzheimer's patients around the world has doubled in the past 26 years.8 Deaths from Alzheimer's disease increased 148% in the same period, making it the fifth leading cause of death. Since the supply of available medical resources is finite and increasingly constrained, we need to employ far more powerful mechanisms for data linkage and sharing in order to conquer Alzheimer's disease."

Maximising the potential benefits of global data linkage and sharing will initially give rise to many difficult multi-factorial challenges: the first and the most important challenge is the fact that the European Union (EU) general data protection regulation (GDPR) has now extraterritorial impacts. GDPR holds data controllers accountable for multiple principles as follows; collection limitation, data quality, purpose specification and use limitation, security safeguards, openness and finally individual participation. When handling personal human data, we need novel information technology to achieve global data sharing in accordance with GDPR principles. New approaches to consent management or dynamic consent[5,6] that allow individual participants to consent or not have been trialled in the UK and EU and by global organisations including Global Alliance for Genomics and Health (GA4GH), while their social implementation will require a bit more time. Second, it is necessary to build public funding frameworks and a consensus policy of "no share, no budget" among funding agencies around the world.[7] Integration of different databases/knowledgebases supported by public funding should be facilitated under such a policy. Researchers who benefit from public funding should waive their claims to priority access and willingly share a significant part of their unpublished research data for the benefit of patients and ultimately, the benefit of all people.

The third challenge is data linkage. Besides successful examples in Estonia, Finland and Denmark, countries with populations greater than 10 million experience difficulties in forming links among many domestic knowledgebases. Japan has a huge National Database (NDB) which aims to collect the whole-nation information on individual patients' medical care and costs. Currently, tight regulation exists limiting the use of the data for academic and commercial purposes. NDB includes a huge amount of information on pharmaceuticals, medical devices and other medical treatments carried out by physicians in all hospitals and out-patient clinics in Japan as a function of lifetime until death.

In May 2019, under enactment of the new law, the Ministry of Health Labor and Welfare decided to connect the NDB and the Long-term Care Insurance database (LCIDB). For more than 20 years, LCIDB has accumulated full data on those who are more than 65 years old and require nursing support from the government. In the future, the link between NDB and LCIDB will lead to a better understanding of how a person's history of medical interventions relates to their eventual medical outcomes or quality of life. Such database linkage might give rise to concerns among the data subjects that research discovery may show linkage of multiple diseases and its misuse by insurance companies. However, the data linkage benefits strategic planning for healthy longevity by allowing analyses of activities of daily living (ADL) and patients and families' burdens for nursing care and investigation of the linkage with past medical cares received by the individual elderly patients. Integral and quantitative analyses of the real-world data of medical and nursing care data will not only allow us to optimise the balance between medical and nursing costs but also to reveal unmet needs for nursing care that will galvanise nursing R&D.

The number of Alzheimer's patients around the world has doubled in the past 26 years.[8] Deaths from Alzheimer's disease increased 148% in the same period, making it the fifth leading cause of death. Since the supply of available medical resources is finite and increasingly constrained, we need to employ far more powerful mechanisms for data linkage and sharing in

order to conquer Alzheimer's disease. Recent multinational studies providing a robust staging system of Ab accumulation that may be useful for monitoring patients throughout the course of AD exemplified critical roles of ADNI database consisting of 18F-florbetapir PET imaging as well as availability of gene expression information from Allen Human Brain Atlas database.[9,10,11]

Another important aspect of global data sharing that is challenging yet needs to be explored is cooperation with the private sector – especially with private entities that are pursuing human enhancement to achieve healthy longevity. The experiences and values gained in present-day Japan must inform future design for other countries which will follow in its ageing footsteps. Healthy longevity for all people is a grand challenge requiring activation and collaboration among young multidisciplinary researchers all over the world and this is reflected in the launch of the U.S. National Academy of Medicine's Grand Challenge in Healthy Longevity. The establishment of a global data linkage and sharing for healthy longevity has the promise to bring major changes to the silver medical R&D. The GFC members hope that this message will prove to be the first step toward making such a scheme a reality for quality of healthy longevity. ■

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Prof Makoto Suematsu
President
Japan Agency for Medical Research and Development (AMED)
Tel: +81 3 6870 2200
contact@amed.go.jp
www.amed.go.jp

Prof Victor J Dzau
President
National Academy of Medicine
VDzau@nas.edu

BioScience: Connecting Growth Factors and Cyclic Peptides

Using cross-disciplinary technology, Dr Kunio Matsumoto, PhD, Professor at Kanazawa University in Japan is extending research on growth factor toward synthetic biologics for regeneration-based medicine and cancer theranostics

Growth of normal cells in our body fundamentally depends on extracellular bioactive proteins called "growth factors". A variety of growth factors play indispensable roles in the development and regeneration of tissues. Tissues and organs in our body have an ability to, more or less, regenerate following injury and diseases, in which growth factors support the intrinsic ability to regenerate. Growth factors not only govern cell growth but also powerfully promote cell survival, cell migration, and tissue formation at extremely low concentrations, and therefore have great potential as biological drugs for therapeutic use. Several kinds of recombinant growth factors are used for treatment of patients.

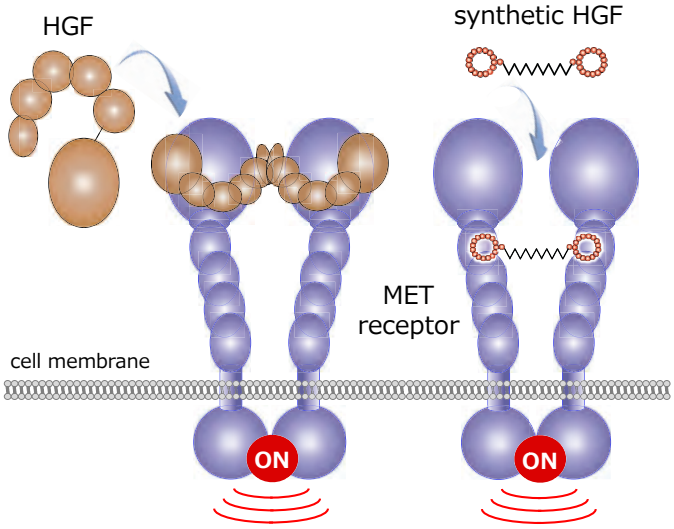

Figure 1. HGF, MET receptor and synthetic HGF (for details: Nature Commun, 6: 6373, 2015).

Hepatocyte growth factor

Hepatocyte growth factor (HGF) was discovered as a growth promoting factor for hepatocytes. HGF affects the cell by binding to its cell membrane-spanning receptor, MET. Like a key, HGF binds to MET as a keyhole in highly specific manner, which leads to activation of MET receptor. The MET receptor is expressed in a variety of cells such as hepatocytes, neurons, gastrointestinal cell, skin cells, etc. Dr Kunio Matsumoto, Professor, Nano Life Science Institute and Cancer Research Institute at Kanazawa University, Japan, has spent much of his career investigating HGF. He also started a venture to facilitate clinical development of recombinant HGF for therapeutic purpose. Double-blind, randomised and placebo-controlled clinical trials have been progressed for treatment of patients with spinal cord injury (phase-I/II) and amyotrophic lateral sclerosis (ALS) (phase-II).

Macrocyclic peptides

Kunio has extended his research through cross-disciplinary collaboration with Dr Hiroaki Suga, Professor, Graduate School of Science at the University of Tokyo. Hiroaki originally established an innovative technology "RaPID (Random nonstandard Peptide Integrated Discovery)" system which enables to discover cyclic peptides against pharmaceutical targets. Peptides and proteins are both composed of amino acids, while peptides are much smaller than proteins. In RaPID system, peptide library with diversity over 10^{13} is screened as binders to a target protein and small peptides with circular structure composed of 10–15 amino acids are finally obtained. Kunio and Hiroaki co-worked to discover the artificial HGF composed of cyclic peptides capable of activating the MET receptor (see figure 1). The synthetic HGF shows biological activities equivalent to native HGF, indicating the creation of almost perfect synthetic HGF. Recombinant growth factor drugs can be replaced by synthetic growth factors in future, which enables a much lower cost-performance.

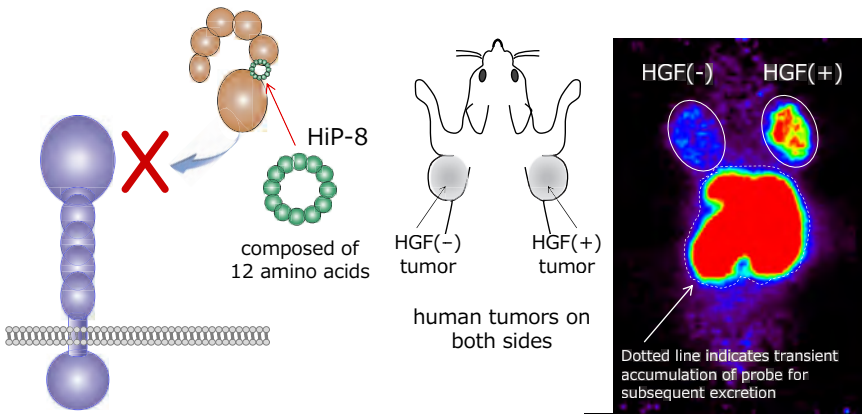

Figure 2. HiP-8 action and PET imaging using HiP-8 as tracing probe (for details: Nature Chem Biol, 15: 598, 2019).

Targeting HGF for cancer diagnosis and therapeutics

Biological pathways often have an important role in more than one process. Processes that are essential for normal physiology are hijacked by diseases such as cancer. The same pathways that are critically important for recovery from tissue injury or other diseases can assist tumour growth. HGF promotes the regeneration and reconstruction of damaged tissues, however, cancer cells commandeer the HGF-MET pathway to promote their own spread. HGF-MET pathway activation leads to an increase in the cell's ability to grow and move in its environment, i.e., spreading. Likewise, HGF-MET pathway activation leads to an increase in the cell's ability to survive even in a stressed condition. Thus, HGF causes cancer cells to become both more invasive/metastatic and more resistant to anticancer drugs.

Kunio commented: "We have a two-pronged approach for the clinical application of HGF. One is the use of HGF and synthetic HGF as regeneration-based therapy for treatment of diseases to facilitate regeneration of tissues. The other is use of an inhibitor and/or a probing molecule of HGF for cancer detection and inhibition."

Using RaPID screening system, the collaborating group by Kunio and Hiroaki recently discovered an inhibitory cyclic peptide, named HGF-inhibitory peptide-8 (HiP-8) (see figure 2). HiP-8 composed of 12 amino acids binds to HGF with outstanding selectivity and affinity. Once HiP-8 binds to HGF, HGF cannot bind to the MET receptor. Highly selective ability of HiP-8 to bind HGF was tested to check its potential as a molecular probe for positron-emission tomography (PET) imaging diagnosis in preclinical model. HiP-8 was excellently accumulated in cancer tissue wherein HGF levels were higher, indicating non-invasive visualization of HGF-positive cancer.

In 2017, a new project for the Nano Life Science Institute (NanoLSI) at Kanazawa University was selected as a project in the World Premier International Research Center Initiative (WPI program) by the Japanese government. Kunio is also working in this new project. The goal of WPI-NanoLSI is to bridge expertise in bioscience and scanning probe microscopy such as high-speed atomic force microscopy (AFM), world-leading technologies developed at Kanazawa University. By using high-speed AFM, Kunio's team succeeded to observe a movie for dynamic change in HGF before and after HiP-8 binding. The molecular shape of HGF was dynamically changing, but it was suppressed by HiP-8. A small molecule inhibits dynamic movement of a large molecule. As Kunio explains, "The most fantastic characteristic point is that of dynamic and real-time movement of biomolecules can be observed by high-speed AFM."

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Dr Kunio Matsumoto, Ph.D
Professor
WPI-Nano Life Science Institute,
Cancer Research Institute
Kanazawa University
Tel: +81 76264 6745
kmatsu@staff.kanazawa-u.ac.jp
www.k-matsumoto-kanazawa-u.org
http://ganken.cri.kanazawa-u.ac.jp/eng/

Towards mobile healthcare with medical-internet of things (IoT) devices

A move towards mobile healthcare with medical-internet of things (IoT) devices is placed under the spotlight here in an insightful piece from Prof D. Chen-Yi Lee from Department of Electronics Engineering, at the National Chiao Tung University in Taiwan

In this article, I will be looking at the impact on society when it comes to the move towards mobile healthcare with medical- internet of things (IoT)[1], technology trends, as well as an interesting example of an electrocardiogram (ECG) and my thoughts on what the future could hold in this exciting field of research.

The impact of medical devices on society

To achieve better medical services with early diagnosis and early therapy, innovative solutions for preventative medicine have been continuously investigated and promoted to both medical centres and local clinics. One of the major driving forces in exploring these solutions for mobile healthcare is to allow limited medical resources for those patients who demand in-time treatment and medical care under the coverage of national health insurance in Taiwan.

Furthermore, both medical teams and the general public need to be re-educated before these new diagnosis/therapy solutions and inherent service models can be accepted. And even some governmental regulations have to be re-adjusted or added to allow these solutions to be deployed for practical usage.

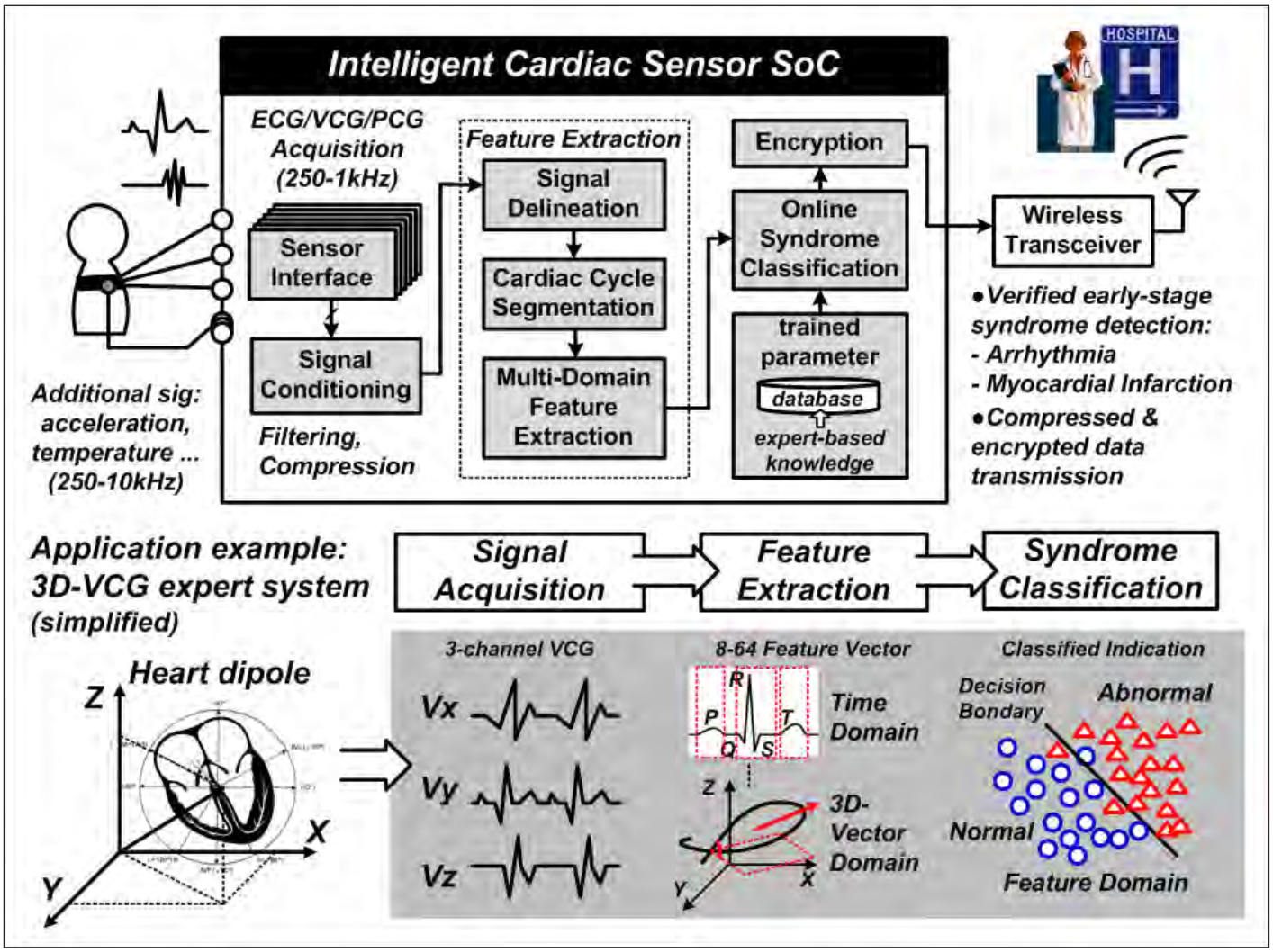
Technology trends

The advances in wireless devices and miniaturised sensors fuel the possibilities of mobile healthcare applications, where medical-internet of things (M-IoT) devices are body-worn or implanted for continuous vital signal recording. To extend the M-IoT monitoring duration, on-sensor biomedical signal processors (BSPs) can be applied to timely extract the critical information for reduced storage and transmission data. Considering the support given to versatile applications with maximised monitoring time, the BSPs should be flexible and accurate with extremely low power operation. In addition, single-type sensor or sensor-fusion solutions should be developed as well to generate valid bio-datasets for follow-up health conditions analysis. Data screening is key to enhance prediction accuracy and avoid false alarm in practical usage. Finally, data security to protect privacy leakage and personal identification to secure the quality of service should be taken into account in these M-IoT devices.

An example on an electrocardiogram (ECG)

An application scenario on an electrocardiogram (ECG) for heart disease prediction is illustrated in the following figure. To meet the requirements of mobile healthcare applications, a specific M-IoT device is demanded with enhanced energy-efficiency so that it can be operated for more than one week with one chargeable battery. In the meantime, the device should be small enough to allow user-friendly wearable usage. Thus, a specific chip needs to be designed to cover the following functions, namely signal acquisition, feature extraction, syndrome classification. In addition, data security and personal identification have to be covered as well. Wireless transmission can be leveraged by those commercial solutions, such as Wi-Fi and Bluetooth depending on how this M-IoT is deployed and used. A preliminary IRB clinical trial based on this M-IoT on the prediction of both arrhythmia and myocardial infarction with accuracy over 95% have been reported. If sensor-fusion is further exploited to cover ECG, vectorcardiogram (VCG), and phonocardiogram (PCG), it is believed that prediction accuracy can be further improved.

There are two issues to be further illustrated to avoid false alarm in practical usage. One is the input signal quality and data validation: this is a very important issue if the input signal has been affected by environmental noises, such as those from power-line, skin contact drift, motion artefact, etc. Different methods have been investigated to reduce these noise sources so that signal to noise level can be further improved. However, these noise-reduction methods may also induce human-made extra noises to signal sources, leading to worse prediction accuracy and even higher false alarm rates. As a result, new approaches to screen out valid datasets from source



signals should be further studied. The other issue is datasets collection from clinical trials. The sample volumes should be large enough to cover different test conditions in model training phase so that prediction accuracy can be accepted in practical usage. This is very important when M-IoT devices are to be deployed in different test scenarios.

However, one problem often encountered is the limited datasets collected for model training, especially in medical diagnosis based on the data-driven approach. Even test samples and procedures have been well defined and planned but it's still hard to cover all test conditions and, hence, prediction accuracy may vary a lot in practical usage. As a result, new approaches toward autonomous learning at the M-IoT device level should be further explored to enhance prediction accuracy and make it reliable for mobile healthcare applications.

A glimpse into the future

Lastly and by no means least, it is believed that with the advances taking place in M-IoT devices, including both sensing capability and autonomous learning, the penetration rate will become much fast than it is today. These new M-IoT devices, together with data-driven operation infrastructure currently under construction, will definitely provide better medical services to society. As a result, the general public will benefit more from a one-stop service platform to lead a better life while enjoying the advantages offered by those M-IoT devices, both developed and under development.

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Prof D. Chen-Yi Lee
Department of Electronics Engineering,
National Chiao Tung University
Hsinchu, Taiwan 300
Tel: +886 357 318 49
cylee@faculty.nctu.edu.tw
http://si2.ee.nctu.edu.tw

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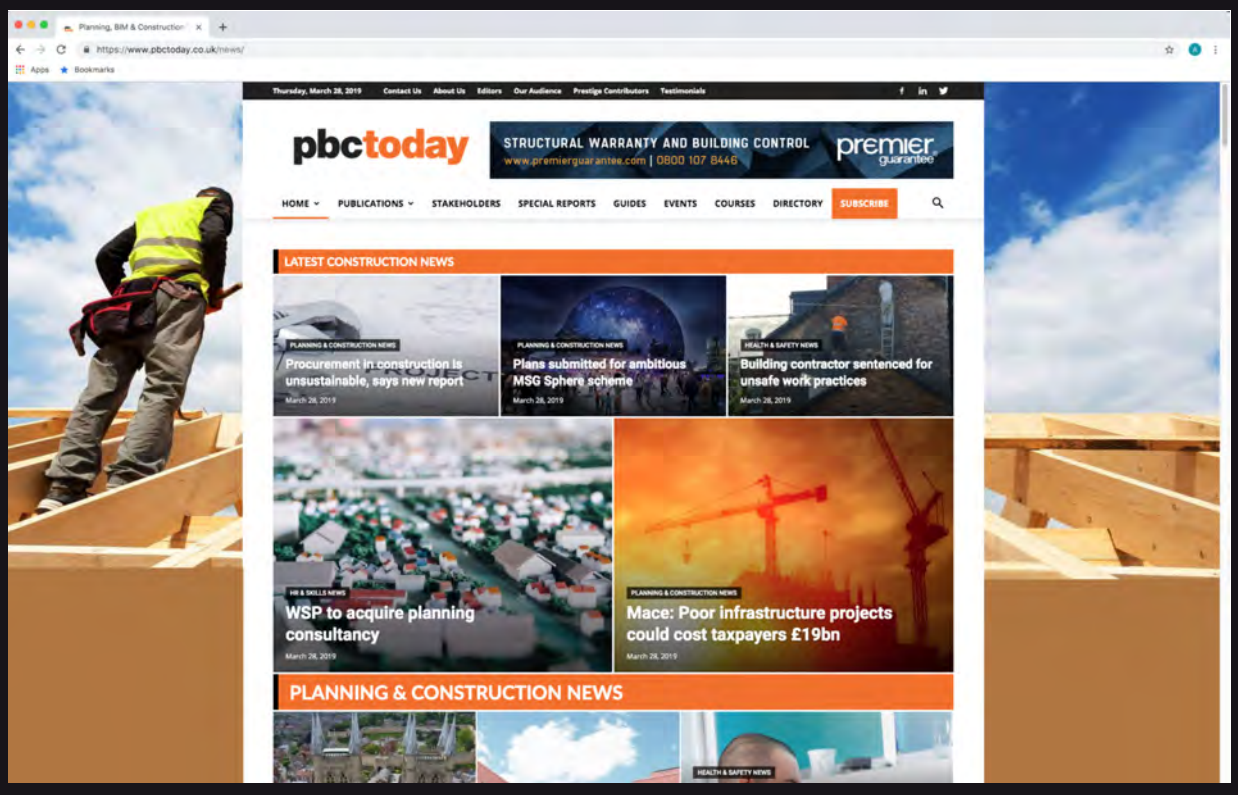

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Medical devices policy: Japan's Ministry of Health, Labour and Welfare

Here, we look at medical devices policy of Japan's Ministry of Health, Labour and Welfare. The Ministry now has Katsunobu Katō in place, who very recently replaced Nemoto Takumi as the Minister of Health, Labour and Welfare in the country

Nemoto Takumi [1] served as the Minister of Health, Labour and Welfare from 2nd October 2018 until 11 September 2019. [2] Katsunobu Katō is currently in this role [3,4]. In this article, we will briefly examine one key policy of Japan's Ministry of Health, Labour and Welfare (MHLW), that concerns pharmaceuticals and medical devices.

Pharmaceuticals and medical devices

On pharmaceuticals and medical devices, we know that MHLW put together the "Strategy of SAKIGAKE" by a project team at the Ministry to lead the world in the practical application of innovative medical products. This team plans strategies from basic research to the practical applications along with related divisions within the MHLW. SAKIGAKE also covers approval reviews, insurance coverage, improvement of infrastructure and the environment for corporate activities, safety measures, as well as global expansion. SAKIGAKE can be summarised as follows:

SAKIGAKE Designation System: Promoting research and development in the country aimed at early practical application for medical devices, innovative pharmaceutical products and regenerative medicines.

Scheme for Rapid Authorization of Unapproved Drugs: This aspect concerns accelerating the practical application of unapproved/off-label use of drugs for serious and life-threatening diseases to include use in Western countries if it satisfies certain conditions. Improving the environment for companies to undertake the development of such drugs is, therefore, vital in this vein. [5]

It is fitting that we now take a look at the "International Pharmaceutical Regulatory Harmonization Strategy – Regulatory Science Initiative" of the MHLW. In essence, this strategy clarifies Japan's policy priorities in the pharmaceutical and medical device sectors, for example, to more effectively promote international harmonisation and cooperation initiatives under the direction of the Minister of Health, Labour and Welfare, who as from September 2019 is Katsunobu Katō and before that, Nemoto Takumi.

> "In August this year, the Medical Equipment Examination Management Division within MHLW approved the target items of the "remanufacturing" system for single-use medical devices, for the first time. We know that MHLW collects used single-use medical devices under the responsibility of medical device manufacturers and distributors, for example. In 2017, the Ministry established laws and regulations to create a system for replacement, reassembly, sterilisation, so that medical devices can be used again."

It is also worth noting here that this strategy aims to show Japan's proactive leadership in the region of Asia and throughout the global community. Policies within this include setting up the "Asian Pharmaceuticals and Medical Devices Regulatory Training Center" within the Pharmaceuticals and Medical Devices Agency (PMDA) [6] to promote pharmaceutical regulations in Japan by regulatory authority officials in Asia. [7]

On the subject of harmonisation, Yasuhiro Fujiwara, MD, PhD, Chief Executive of the PMDA looks to the organisation playing an active role in discussions concerning international harmonisation of regulations and he wants to raise standards at Asian and other regulatory authorities. "Without being bound by precedents, the PMDA will proactively pursue new initiatives and

contribute to the advancement of the public health and safety of all people in Japan," he added. [8]

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As Katsunobu Katō is now the Minister of Health, Labour and Welfare in Japan, we wish him well in his recently acquired position as he pushes forward a wide array of policy issues of which pharmaceuticals and medical devices are just a very small part. ■

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Healthcare early detection technology: Voice analysis technology

Shinichi Tokuno from the Department of Voice Analysis of Pathophysiology, Graduate School of Medicine, at the University of Tokyo, lifts the lid on voice analysis technology for healthcare

It is possible to tell from a person's voice that he or she is unwell. This is not only possible with the familiar voices of family members and friends, but also with the voices of unfamiliar people. Therefore, it is expected that the voice has some characteristics that change depending on one's physical condition. Apart from clinical diseases in the field of otolaryngology, which directly affects the voice, it has long been pointed out that patients with other conditions, including depression, have a characteristic quality to their voice (Newman et al., 1938). Over time, attempts have been made to objectively evaluate speech characteristics specific to these diseases.

> "Taking a slightly different approach, we focused on the reduction in emotion expression that manifests when a person is stressed or depressed and developed the application 'MIMOSYS (Mind Monitoring System)', which automatically monitors the mental health of the owner of the smartphone from their voice during conversations on the smartphone (Tokuno et al., 2018)."

Initial research involved analysis of the speaking rate, switching pause and pause rate in patients with depression (Weintraub et al., 1967). Then, with the development of computers, research began on analysis of the basic frequency of speech (Nilsonne et al., 1988) and analysis of formant frequencies formed by resonance when the vocal cord vibrations pass through the vocal tract (Flint et al., 1993).

Recent changes in the human-machine interface have increased the opportunity for humans to operate devices using voice activation; in other words, there have been increased opportunities to capture speech with devices. Therefore, attention has been focused on research attempting to use speech as biomarkers and the latest research

has made it possible to move beyond simple frequency analysis, with research flourishing in fields that make full use of computers such as machine learning and deep learning (Fang et al., 2018).

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Unlike biomarkers obtained from other specimens, voice analysis is cost-effective because it does not require special devices or reagents and it can be measured repeatedly using non-invasive and simple methods. Therefore, it can be used not only for screening but also for household monitoring, which may enable early detection of disease. Taking a slightly different approach, we focused on the reduction in emotion expression that manifests when a person is stressed or depressed and developed the application 'MIMOSYS (Mind Monitoring System)', which automatically monitors the mental health of the owner of the smartphone from their voice during conversations on the smartphone (Tokuno et al., 2018). This system is based on voice Sensibility Technology (ST), which captures emotions from changes in the basic frequency of the voice. MIMOSYS calculates 'Vitality', which is the degree of mental health, from the percentage of emotion within the measured conversation by ST. As Vitality varies significantly depending on the content of the conversation and the other party in the conversation, we devised the indicator of 'Mental Activity' based on variations in Vitality over a two-week period and the mean Vitality over that period. We verified this Vitality and Mental Activity with more than 10,000 people in a variety of situations and confirmed its effectiveness. That is, Mental Activity accurately showed the user's mental fluctuations; in other words, it showed the trends in the degree of stress. The algorithm we developed has already been commercialised for industrial medicine in Japan and applications using our algorithm have been pre-installed in a number of smartphones for personal use. Currently, we are adding a function for analysing set phrases read aloud for users who do not make many telephone calls and we are verifying the effectiveness of these applications in multiple languages. In addition to health applications, we are also considering other applications such as mental healthcare for athletes.

MIMOSYS is mediated via emotion, so it makes human-like judgements, but it is difficult to capture subtle changes between different diseases. Therefore, we are also attempting methods that compare voice characteristics directly, without using emotions. We have already achieved results for depression, Parkinson's disease and dementia and we are working on expanding the application to other diseases.

As stated above, voice biomarkers have a broad range of applications and they have great potential.

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MIMOSYS

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東京大学
THE UNIVERSITY OF TOKYO

Shinichi Tokuno
Project Associate Professor
Department of Voice Analysis of Pathophysiology
Graduate School of Medicine
The University of Tokyo
Tel: +81 3 5800 9168
tokuno@m.u-tokyo.ac.jp
http://www.univ.tokyo/mimosys/trial/index_en.html

Developing a semi-automated circulation system for cardiopulmonary bypass

Asako Tokumine, PhD, Assistant Professor at Kindai University explains her work in developing a new cardiopulmonary bypass system

Since my graduate school mentor was developing simulating software for a cardiopulmonary bypass device, my project was to develop a cardiopulmonary bypass simulator and to examine the educational effect using the simulator. During the research of developing an extracorporeal circulation simulator, we found that there is a certain operating condition in the operation of a simulator by an extracorporeal circulation engineer. We are currently developing a semi-automated circulation control system for a heart-lung machine. Many issues needed to be addressed in the field of extracorporeal circulation when I was in graduate school. Here are some examples. Why is extracorporeal circulation necessary? A cardiopulmonary bypass device is used only when the heart is stopped but should it be used only to maintain blood circulation? Are there any other less-invasive methods? Perfect manual operation can be sound good if it reflects a personalised procedure. However, if the operation of a cardiopulmonary bypass device is carried out under circumstances where unified safety awareness is not established, the procedure can only be worrisome. We had an opportunity to discuss with researchers in the cognitive science field and concluded that there is too much information to grasp even though a cardiopulmonary bypass device is a critical system. I believe that the system has a part in which humans can operate and a part in which a machine should operate as a system.

When I was developing the extracorporeal circulation simulator, I observed hundreds of examples of perfusionists manipulation for the perfusion technique. I noticed that there was a basic operation procedure based on a trend graph obtained from the extracorporeal circulation simulator. It is necessary to operate the simulator according to the surgeon's instruction during open-heart surgery.

Also, it is essential to adjust the operating conditions as necessary while managing the progress of the surgery. Since cardiopulmonary bypass devices replace the heart during the surgery, discontinuation of a blood delivery pump never happens. Based on the above situation, I thought of systemising blood delivery so that blood delivery can be maintained. The basic algorithm has been completed already at this point. The primary objective of this study is to systemise blood circulation during open-heart surgery and to maintain safe blood circulation. It has been 60 years since the cardiopulmonary bypass device was established. However, few changes have made in the device and the device is mostly manually operated. Although the device has the potential to be automated, it has not been put into real use. I believe that there must be areas that can be automated.

Cardiopulmonary bypass is a critical system to substitute for the heart. Therefore, errors that can be prevented should be able to be replaced by a device system. However, complete automation of the system is considered difficult. Maybe a specialised engineer can manually perform the adjustment of a suction circuit according to the surgical process as necessary. As I mentioned previously, an operation of the current cardiopulmonary bypass device is cumbersome. There are several procedures which require manual involvement. I think that such procedures should be conducted manually because such procedures require coordination with the surgical processes. On the other hand, it is possible to safely control blood flow automatically using multiple monitors in the main blood circuit that is responsible for blood circulation. The number of cardiopulmonary bypass device-related accidents has hardly decreased. Improvements in technology have reduced the number of breakdowns of component parts.

However, errors caused by the operators and by miscommunication between staff members are evident. The number of patients with heart failure is increasing in Japan. Novel technologies have been developed and less invasive techniques are available. However, the number of cases where surgery was performed by switching back to a cardiopulmonary bypass device has been increasing

due to the fear of using a new technique. A cardiopulmonary bypass system is a critical system. Therefore, I believe that extracorporeal circulation operation should be performed safely with certain standards no matter who operates it. The basic algorithm has been completed. We will go into a verification process next, although there are several problems. The first issue is the blood reservoir. In research-level experiments, a water tank has been used to resemble the blood reservoir.

However, the current blood reservoir needs to be improved in order to be used in an actual clinical setting. A continuous measurement cannot be performed with the current blood reservoir. I recently found an idea for reservoir level measurement. It may be possible to solve it. A blood delivery pump gradually increases blood flow after turning on a switch of the cardiopulmonary bypass device. Various signals involved in the operation of the device are utilised for the input so that air will never be mistakenly delivered to a patient. The machine can also respond to both abnormal blood delivery pressure and blood leakage. Operation of the device should be conducted in coordination with the surgical field. It may become possible to control the cardiopulmonary bypass device in the surgical field using a controller installed in the surgical field if this method is applicable. A basic algorithm was developed in 2018. Thus, we are still at the beginning stage. We will conduct operation verification in the future and events that the algorithm cannot handle will be addressed as necessary.

I believe that highly invasive procedures, such as a procedure requiring cardiac arrest will certainly decrease within the next ten years. However, procedures which require blood circulation to be arrested will not be zero either. I believe that a cardiopulmonary bypass device will be automatically operated far more safely in the next ten years. It will be possible not only to increase the safety of operation but also the safety of patients.

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KAKENHI

近畿大学
KINDAI UNIVERSITY

Asako Tokumine, PhD
Assistant Professor
Clinical Engineering Laboratory,
Department of Biomedical Engineering,
School of Biology-Oriented Science and
Technology, Kindai University
Tel: +81 736 77 3888
tokumine@waka.kindai.ac.jp
www.kindai.ac.jp/bost/

Periodontal disease: Structure of Mfa1 fimbriae

Professor Yoshiaki Hasegawa, Aichi Gakuin University, Department of Microbiology, School of Dentistry, discusses the structure and biogenesis mechanism of Mfa1 fimbriae from the periodontal pathogen *Porphyromonas gingivalis*

Periodontal disease is an inflammatory disease caused by infection of the gums and results in the collapse of the structures supporting teeth. It is very common worldwide, affecting as much as 50% of the global population.

Moreover, the disease has been shown to be associated with various systemic diseases, including, cardiovascular diseases, diabetes, preterm birth, pulmonary disease, and rheumatoid arthritis. Periodontitis is a chronic inflammatory lesion induced and maintained by the polymicrobial biofilm formed on teeth, according to the polymicrobial synergy and dysbiosis hypothesis.

In recent years, microbiome analysis and animal models of periodontal disease have led researchers to propose the hypothesis that *Porphyromonas gingivalis* is a keystone pathogen in causing dysbiosis of the dental plaque bacterial flora.

The periodontal pathogen *Porphyromonas gingivalis*

P. gingivalis, a Gram-negative anaerobic bacterium, produces several known potential virulence factors: Fimbriae, proteases like gingipains, and lipopolysaccharides. Fimbriae are fibrillar structures formed by the polymerization of fimbrilins on the bacterial surface. They play a pivotal role in *P. gingivalis* colonization, invasion, establishment, persistence within the host, and evasion from immune system destruction. *P. gingivalis* typically expresses two different types of fimbriae, FimA and Mfa1. FimA and Mfa1 fimbriae are primarily composed of polymers of the FimA and Mfa1 proteins encoded by the *fimA* gene and the *mfa1* gene, respectively.

In addition to structural proteins, mature FimA and Mfa1 fimbriae contain the accessory proteins, FimC-E and Mfa3-5, respectively. However, the structure and biogenesis mechanisms of both fimbriae have not been closely examined.

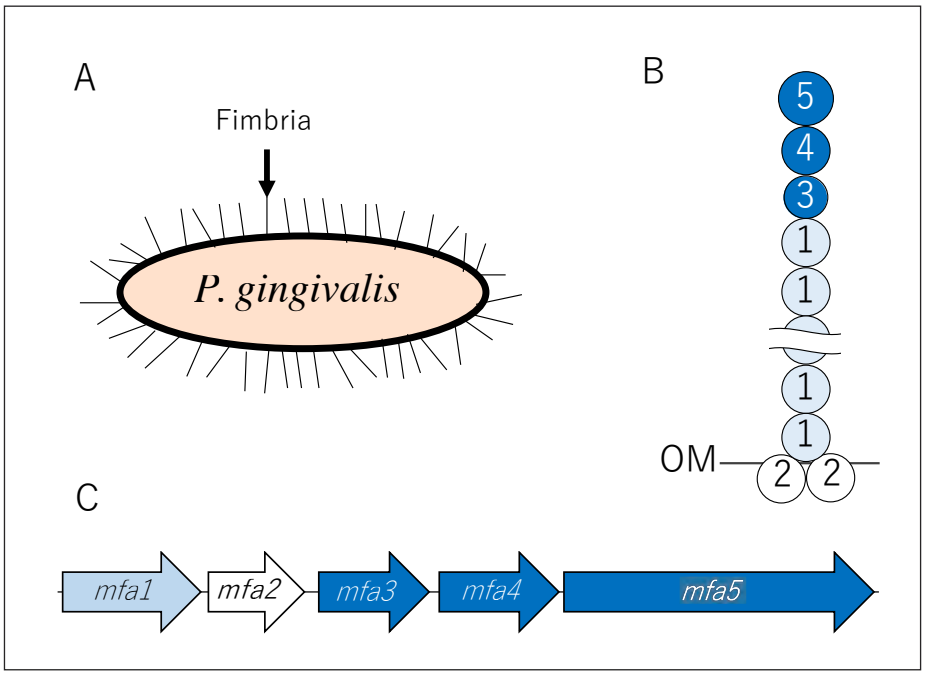

Figure 1. Mfa1 fimbriae of Porphyromonas gingivalis. (A) A depiction of P. gingivalis fimbrae on the cell surface. (B) An illustration showing Mfa1 fimbriae of P. gingivalis. Mfa1 fimbriae are composed of Mfa1 polymer associated with Mfa2, Mfa3, Mfa4 and Mfa5. (C) The mfa gene cluster in the P. gingivalis chromosome. Modified from (Hasegawa et al. JDR. 2016)

Structure and biogenesis mechanism of Mfa1 fimbriae

Since 2007, we have been analysing the structure and biogenesis mechanism of Mfa1 fimbriae. We have determined that the mature Mfa1 fimbria is generated via an *mfa* gene cluster comprised of five proteins: Mfa1, Mfa2, Mfa3, Mfa4, and Mfa5. To examine the roles of Mfa2-Mfa5, the deficient mutant strains of these genes were constructed. In our results, we found that the main shaft portion consists of Mfa1, while Mfa2 is located in the basal portion of the fimbriae and functions as an anchor and an assembly and elongation terminator.

In addition, Mfa3 is localised in the distal tip portion of the Mfa1 fimbriae, and thus may play a role as a ligand to receptors on host cells and other oral bacteria. Mfa3, Mfa4, and Mfa5 all participate in the assembly of an accessory protein complex on the tips of fimbriae. Mfa5, which contains a C-terminal domain and von Willebrand factor type A domain, is translocated to the cell surface by the Type 9 secretion system. Our proposed a structure model of Mfa1 fimbria is shown in Figure 1.

"In recent years, microbiome analysis and animal models of periodontal disease have led researchers to propose the hypothesis that *Porphyromonas gingivalis* is a keystone pathogen in causing dysbiosis of the dental plaque bacterial flora."

Benefits of our project

Since the protein located at the tip of the fimbria often functions as an actual adhesion in fimbriae of many pathogenic bacteria, it is thought that the tip proteins of Mfa1 fimbria of *P. gingivalis* play an important role in the colonization of periodontal tissue. If we are able to identify the binding partner of the tip accessory proteins of Mfa3-5, we will be able to reveal the colonization mechanism of this bacterium.

Furthermore, this information would allow us to devise a new therapeutic strategy for the prevention of colonization. In the future, we hope to lead in the development of locally administered treatments, such as drugs or peptides that can inhibit the function of *P. gingivalis* fimbria. These treatments could be applied after professional mechanical tooth cleaning, such as scaling by a dentist. We hope that the results of these research projects will lead to the development of new therapeutic and preventive drugs for periodontal disease targeting Mfa1 fimbriae of *P. gingivalis*.

Recently, Xu et al. (2016) clarified the crystal structure and polymerisation mechanism of a group of proteins which predominantly exist in human microbiomes and are presumed to be a fimbrilin of class Bacterioidia (of which *P. gingivalis* is also a member). In addition, the fimbrae of this family did not belong to any current type of bacterial fimbriae (type I to IV) and were, therefore, classified as V-type fimbriae. We hope that by exploring these research avenues, future research will be able to lead the development of a new treatment strategy that controls the bacterial flora inhabiting the intestinal tract.

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Yoshiaki Hasegawa is a Professor at Department of Microbiology, College of Dentistry, Aichi Gakuin University. After completing a PhD at the Department of Periodontology, College of Dentistry, Aichi Gakuin University, he pursued a post-doctoral experience at the Department of Oral Biology at University of Florida College of Dentistry (Dr Lamont's Lab). He has been working at Aichi Gakuin University (Dr Yoshimura's Lab) and Asahi University (Dr Murakami's Lab) for the last 12 years to determine structure and function of *P. gingivalis* fimbriae.

科研費
KAKENHI

AICHI GAKUIN
UNIVERSITY
愛知学院大学

Yoshiaki Hasegawa
Professor
Aichi Gakuin University, Department of Microbiology, School of Dentistry
Tel: +81 52 751 2561
yhase@dpc.agu.ac.jp
www.agu.ac.jp/english/educationarl_org/dentistry.html

The Japanese Society of Nephrology: Research and education to tackle kidney disease

The Japanese Society of Nephrology engages in a wide range of activities to, including research, developing human resources, providing lifelong education and disseminating knowledge to the public, to tackle kidney disease and promote health, as we find out here

The JSN is developing a five-year plan to define its future activities focusing on the key areas of: strategy and medical policy; basic research; clinical research; education and development of human resources; internationalisation; and local contribution and industry-university collaboration.

Through JSN's International Committee, relationships with bodies such as the American Society of Nephrology and the European Renal Association-European Dialysis & Transplant Association have been strengthened, while ties with other Asian countries are being consolidated through the Asian Forum of Chronic Kidney Disease Initiative.

The Japanese Society of Nephrology (JSN) carries out investigations and research concerning all aspects of medicine, health and treatment related to the kidneys in order to improve public knowledge and advance academic achievement.

The kidneys play a vital role in keeping the blood clean by excreting waste materials into the urine. They also help to maintain body fluid volume and pH (acidity or alkaline) of the blood.

Furthermore, the kidneys secrete a hematopoietic hormone, improve anaemia and are involved in the metabolism of calcium and phosphorous.

The main fields of nephrology are concerned with investigating the structure and function of the kidneys; to search for the causes of symptoms such as proteinuria, hematuria or edema and renal function deterioration observed in clinical practice; to actively treat kidney disorders; and to provide renal replacement therapy, such as haemodialysis, peritoneal dialysis or transplantation, for patients for have developed end-stage renal disease.

The JSN's mission is to support those working in nephrology by holding regular meetings to act as a forum for the diffusion of information, producing journals, coordinating clinical research, promoting cooperation with related bodies in Japan and internationally, and proving recognition to those who have made significant contributions to the field.

The JSN currently has over 10,000 members. Dr Naoki Kashihara of Kawasaki Medical University has been President of the organisation since June 2016.

"We believe that research to overcome diseases develops gradually, not via a simple course, but along a more convoluted pathway. On behalf of the whole organisation, I am determined to make progress step-by-step, without delay, and with the expectation and the objective of educating the next generation," Dr Kashihara wrote on the JSN website.

To facilitate this progress, the JSN is developing a five-year plan to define its future activities focusing on the key areas of: strategy and medical policy; basic research; clinical research; education and development of human resources; internationalisation; and local contribution and industry-university collaboration.

A key pillar of the five-year plan will be a greater focus on increasing diversity and promoting gender equality.

In addition, to support collaboration between the different workforces in the clinical field, the JSN will launch the Certified Nephrology Nurse course to strengthen the integration of general nurses, dieticians and pharmacists, and focus on nurturing a wide variety of next-generation career personnel who are not limited to being doctors.

"We believe that research to overcome diseases develops gradually, not via a simple course, but along a more convoluted pathway. On behalf of the whole organisation, I am determined to make progress step-by-step, without delay, and with the expectation and the objective of educating the next generation."

One of the big concerns for the JSN is the declining international competitiveness of Japan's basic research, as indicated by a reduction in the number of papers from the country published in journals such as the Journal of the American Society of Nephrology and Kidney International.

To support basic research, the JSN will back education programmes and nurture young researchers, help to establish a virtual resource centre for renal biopsy and facilitate students studying abroad. It will also submit a five-year proposal to the MHLW and the Japan Agency for Medical Research & Development highlighting the key issues to be resolved.

In addition, the JSN will expand its database of renal disorder registration. The Japan Renal Biopsy Registry (J-RBR) is one of the largest renal biopsy registries in the world. The Japan Chronic Kidney Disease Database (J-CKD-DB) is a less labour-intensive database, containing more than 100,000 patients, which is used by the MHLW. Individual information on the J-CKD-DB will be linked to the J-RBR for complementary purposes.

To improve the quality of nephology care, the JSN will build platforms with other stakeholders, including the MHLW, AMED and the Ministry of Education, Culture Sports, Science & Technology and consolidate connections through scientific programme workshops.

Through JSN's International Committee, relationships with bodies such as the American Society of Nephrology and the European Renal Association-European Dialysis & Transplant Association have been strengthened, while ties with other Asian countries are being consolidated through the Asian Forum of Chronic Kidney Disease Initiative.

To support the development of new renal disorder treatment drugs, the JSN is establishing a new regulatory science research organisation together with the relevant ministries. In order to create efficient countermeasures, the JSN is creating joint committees with various other societies.

The JSN has successfully expanded in recent years and will continue to pursue growth with the core mission of contributing to society at large.

"We need broad support, not only from the society members but also from citizens," Dr Kashihara said.

"For us to overcome renal disorders, it is essential that we work together with people from various fields. We anticipate that you will provide your understanding, cooperation and knowledge to further the JSN's mission." ■

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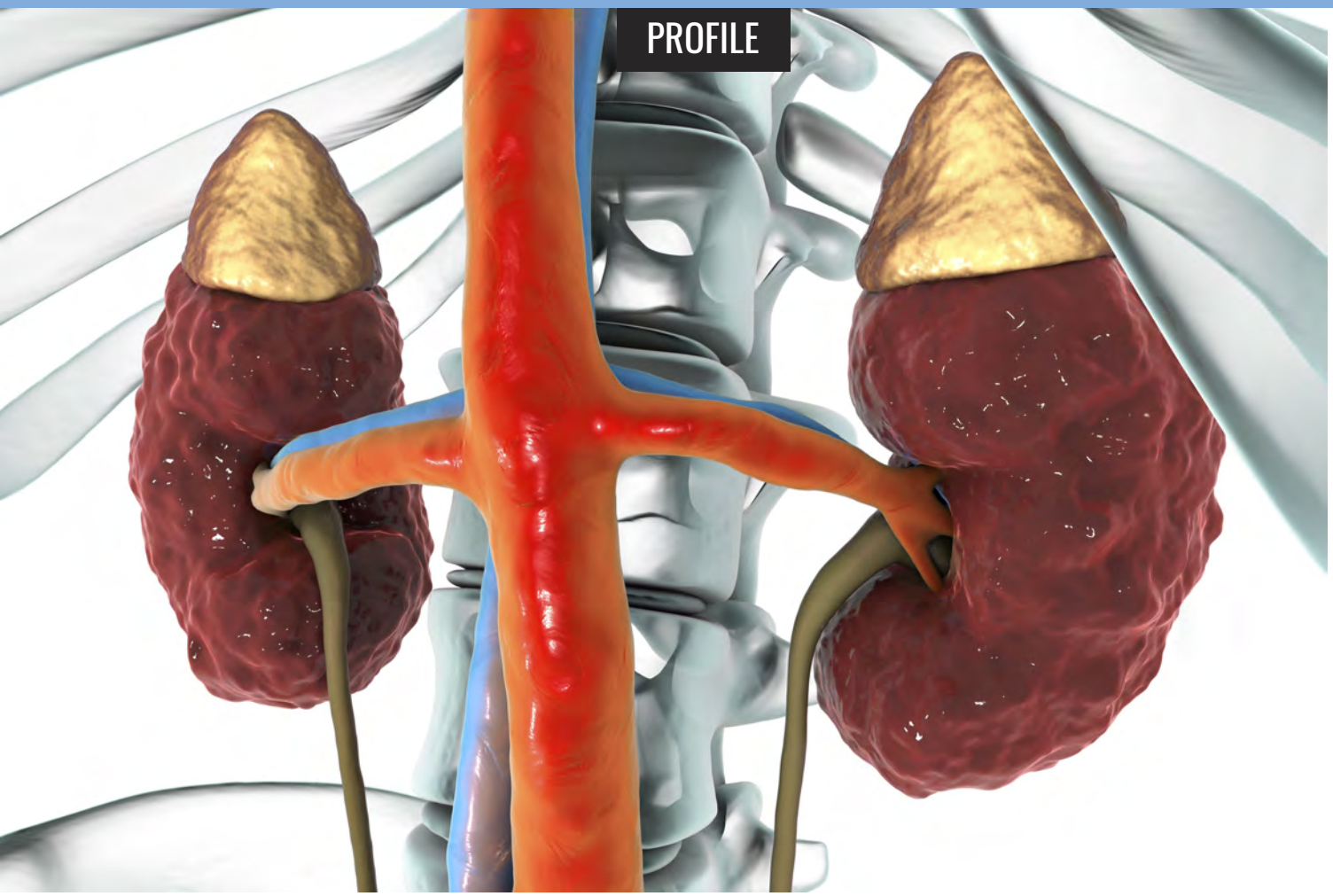

The importance of keeping the kidneys healthy

Here, Dr Masanori Katakura from the Laboratory of Nutritional Physiology, explains the importance of keeping the kidneys healthy, as well as the surprisingly common condition, chronic kidney disease (CKD)

The kidneys are an important organ to maintain the homeostasis of body fluids, regulation of blood pressure, body fluid volume, production of red blood cells and to keep bones strong and healthy. Remarkably, given the importance of the kidneys, it is entirely possible to live a full and healthy life with just one kidney.

When the kidneys do not work as well as they should, this is referred to as chronic kidney disease (CKD) or chronic renal failure (CRF). CKD is a surprisingly common condition which is often associated with aging. According to the National Kidney Foundation, 10% of the global population is affected by CKD, with more than 2 million people currently receiving treatment with dialysis or a kidney transplant. It is clearly a global health problem that has a high economic cost. While it is widely known that CKD is an independent risk factor for cardiovascular disease, it is perhaps less well known that kidney failure can have significant negative impacts on the heart, brain, retinas and liver.

Changes in inflammatory status in the plasma and kidneys in the rat chronic renal failure model

To elucidate the relationships between inflammation and renal functions, the rats had 5/6 kidneys removed when they were 11-weeks old. Every four weeks, the rats were housed in an

individual metabolic cage and their urine was collected for 24 hours. Sixteen weeks after surgery, plasma and kidneys were collected for biochemical and histological analysis. Urinary albumin excretion was shown to be gradually increasing in the renal failure group, as compared to the control sham group. Reactive oxygen levels and lipid peroxide levels in the kidney, however, did not differ at 16 weeks after surgery. Lipid peroxide levels in the plasma of the renal failure group significantly decreased compared with the control group at four weeks after surgery – but not in the plasma at 16 weeks. The negative correlation was found between creatinine clearance and lipid peroxide levels in plasma at 4 weeks after surgery. Tumour necrosis factor (TNF)-α and transforming growth factor (TGF)-β1 levels in the kidney at 16 weeks significantly increased in the renal failure group compared with the control group. The positive correlation was found between creatinine clearance and IL-6. The negative correlation was found between creatinine clearance and TNF-α or TGF-β1. The positive correlation was between urinary albumin at 12 weeks and TGF-β1. These results have indicated that inflammation an important factor to determine renal functions after that surgery takes place.

Effects of chronic renal failure on cognitive function and neurogenesis in rats

It is reported that the risk of dementia in dialysis patients is higher than that in healthy individuals. Iwata et al. recently reported a decline in CKD grade was associated with a faster rate of decline regardless of amyloid pathology in women (Alzheimer's Dement (NY). 12(4)765-774, 2018). However, the detailed mechanism underlying this relationship remains poorly understood. Our team examined the cognitive function and behaviour of the rat renal failure models that were prepared by function by removing the whole right kidney, the left kidney ligated one part of the renal artery and blocked the blood flow, using histological and behavioural tests. There was a decrease in creatinine clearance and an increase in urinary albumin excretion in the renal failure group compared to that of the control group. Five months following surgery, brains were harvested and fixed using 4% paraformaldehyde, following which frozen sections were prepared using a cryostat and subjected to fluorescent immunostaining (Ki67, Iba-1). The abundance of Ki67 positive cells, proliferating cells and Iba-1 positive cells which are expressed in monocyte or macrophage, in the hippocampus, was evaluated. The number of Ki67-positive cells in the hippocampus was lower in the renal failure group than in the control group. The number of Iba-1 positive cells in the hippocampus tended to increase in the renal failure group compared to the control group. Behavioural differences between the control group and the renal failure group were observed using the novel object cognitive test for the investigation of learning and memory. The proportion of search time for the new object significantly decreased in the renal failure group compared to the control group, indicating a decline in learning and memory function in the renal failure group. These results have suggested that increased inflammation in the hippocampus caused by chronic renal failure may suppress the number of new-born cells, called neurogenesis, in the hippocampus, resulting in reduced cognitive function.

> "According to the National Kidney Foundation, 10% of the global population is affected by CKD, with more than 2 million people currently receiving treatment with dialysis or a kidney transplant. It is clearly a global health problem that has a high economic cost."

Through these experiments, we will clarify the relationship between the kidney and other organs and continue basic research to help reduce complications due to the progression of renal failure. To keep the kidneys healthy leads to extending the healthy life expectancy.

Dr Masanori Katakura
Kidney dysfunction affects learning ability
Laboratory of Nutritional Physiology
Department of Pharmaceutical Sciences
Josai University, Japan
Tel: +81 49 271 8015
mkatakur@josai.ac.jp
www.josai.ac.jp

A focus on promoting healthy ageing in Hong Kong

Hong Kong's Elderly Health Service has an increasingly important role to play in improving primary healthcare of the elderly, as this article discovers, with a special focus on recommended exercise as one of the many elements to promote healthy ageing in individuals

The Elderly Health Service in Hong Kong has been running since 1998 and today, it aims to improve the primary healthcare for the elderly, promote healthy living, improve self-care ability and strengthen the area of family support so that disability and illness can be kept to a minimum. [1]

When it comes to ageing, this is an inescapable fact of life. Changes in the mind and body occur, of course, but many symptoms may be due to diseases that can be remedied or treated. As such, the Elderly Health Service urges the elderly and their carers to be knowledgeable about normal ageing, so they can distinguish between disease and normal ageing and, therefore, ensure early and proper treatment for diseases. [2]

The Elderly Health Service's website hosts a wealth of information about healthy ageing, with very useful sections on a healthy diet, mental health and relationships, for example. Another area they discuss is exercise, which they recommend for the elderly daily to improve both mental and physical health. Of course, this has to be tailored to the ability and target of the individual. For example, we find out that for beginners who have not been doing any exercise, they must begin with an exercise of milder intensity and a shorter duration of around 10 to 15 minutes for every session. This approach reduces the risk of injury caused by progressing too fast and it is also underlined that each workout must start with a warm-up and stretching exercises, and finish with both cool-down and stretching exercises.

Many questions about exercise are answered on the website of the Elderly Health Service, such as "Which type of exercise is the best?". The response given is that all exercise should be enjoyable, safe and not too strenuous for the elderly. Certainly, it can be safer and more fun to exercise with friends rather than alone. Three main kinds of exercise are highly recommended:

- Aerobic exercise of moderate-intensity;
- Muscle-strengthening exercise and;
- Stretching exercise (and balance exercises).

Also, we find out that when it comes to what exercises are suitable for the elderly, these include walking, swimming, cycling on static bikes and tai chi. Concerning how much exercise an elderly person should do, at least 150 minutes of moderate-intensity aerobic exercise is recommended per week. For instance, one way to do this is 30 minutes daily for at least five days per week. The World Health Organization (WHO) suggests that the elderly should accumulate up to 300 minutes of exercise to gain health benefits if the person is physically able to do so.

Other exercise recommendations include those for patients with chronic diseases, on the condition that their health conditions are stable as assessed by professionals in the field in terms of the relevant safety precautions. For example, diabetic patients can choose different kinds of exercise but they should be equipped with carbohydrate snacks like bread or biscuits in the event they are required. Besides, each exercise session should be confined to 20-60 minutes to avoid hypoglycaemia (a low blood sugar) [3] induced by prolonged exercise. Another good example to look at here is exercises for patients with osteoarthritis of the knees, indeed it is recommended by the Elderly Health Service in Hong Kong that they should choose exercises that impose relatively light loading to the joints, such as

walking, swimming or tai chi. Having said that, it is advised that exercises involving walking up and down stairs, slopes or deep squatting must be avoided. [4]

In conclusion, exercise is just one of many ways to encourage healthy ageing. Others include aspects of self-care [5], such as massage, foot care, coping with fatigue and assistive devices for daily living. You can also read in detail about elements of home safety [6], for example, advice on preventing falls or even how to be prepared for winter. There is also a section on smoking and drinking [7], that includes information, such as the harm passive smoking does on an individual, as well as how alcohol can harm your health. Exercise is a really good example of positive activity that the elderly benefit from and it certainly encourages them to enjoy their later years and live a fruitful life. [8] ■

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Dementia care workforce: Hong Kong and the train-the-trainer approach

Here, experts explain the intricate situation of Dementia care in Hong Kong, and why it could benefit from a train-the-trainer approach

Helen Chan[1], Kenny Chui[2], Florence Ho[2], Eunice Hui[2], Bel Wong[2], Alison Bowes[3], Timothy Kwok[2]

[1]The Nethersole School of Nursing, Faculty of Medicine, The Chinese University of Hong Kong, [2]Jockey Club Centre for Positive Ageing, Hong Kong, [3]Dementia Services Development Centre, University of Stirling

Providing care for people with dementia and their family carers is at the top of the policy agenda in ageing societies because this disease is one of the major causes of dependency and disability among older adults. Approximately 50 million people lived with dementia worldwide, and the prevalence is expected to surge continuously at a rate of nearly 10 million new cases every year (World Health Organization, 2019). Although a range of care services has been developed to meet their complex care needs, the care competence of staff members, who play a key role in the quality of care, is gaining considerable attention. Literature has consistently advocated the importance of training and empowerment in preparing the staff in dementia care (Figueiredo, Barbosa, Cruz, Marques, & Sousa, 2013; Surr & Gates, 2017; Tsaroucha, Benbow, Kingston, & LeMesurier, 2011).

Hong Kong is facing a rising demand for dementia care due to the ageing population. A local survey revealed that dementia care is a challenging issue for staff in long-term care settings (Lee, Hui, Kng, & Auyeung, 2013). The recently released Mental Health Review Report by the Food and Health Bureau of the HKSAR government (2017) highlighted the need for capacity building and workforce training to ensure the quality of dementia care. However, relevant training is limited to long-term care and residential care services, and most of the attention is focused on disease knowledge and skills in handling the challenging behaviours of people with dementia. Although a more structured training programme was recently developed for health and social care staff in community care settings to support the newly launched Dementia Community Support Scheme, the training is limited to staff members who are directly involved in the service. Systematic reviews on studies on dementia care training concluded that didactic teaching and task-oriented activities on occasional sessions demonstrate limited efficacy on staff care competence, especially on the staff's attitudinal change (Spector, Revolta, & Orrell, 2016; Surr & Gates, 2017).

To address the urgent and extensive staff training needs in dementia care in Hong Kong, the Jockey Club Centre for Positive Ageing (JCCPA) launched a three-year Best Practice in Dementia Care Programme between 2016 and 2019 in collaboration with the Dementia Services Development Centre (DSDC) of the University of Stirling, UK. This programme has been widely adopted in the UK and other European countries over the past decade (DSDC, 2019). In the present project, this community-wide programme reached approximately 1,500 staff members from over 70 local non-government organisations, including community and day care centres, residential care homes for the elderly and outreach teams in Hong Kong. Initially, 17 experienced care professionals in elderly care services received training from the DSDC. These trainers then conducted training for 218 care professionals who committed to be facilitators in their own care settings or services to provide in-service training to colleagues. This training aimed to equip the facilitators with knowledge and proper caring attitude towards people with dementia as well as empower them with skills to provide guidance to their colleagues in their workplaces.

To ensure holistic care, the programme structure covered six domains: (i) dementia and persons with dementia; (ii) person-centred care and building meaningful relationship; (iii) communication and behaviours; (iv) support for people with dementia, family and carers; (v) health and wellbeing; and (vi) legal aspects and issues related to dementia. The domains were introduced on a monthly basis for six months. Two sets of training kits,

Graduation ceremony of Jockey Club Best Practice in Dementia Care Programme in 2019

including a facilitator guide, an introductory booklet and six booklets for each domain, were respectively developed for the residential and community care services. The training materials were adapted to the socio-cultural context of the local communities and translated to Chinese to facilitate self-directed learning.

The Train-the-Trainer approach, which is the key feature of the aforementioned training, increased the programme's reach and sustainability. The facilitators acted as a change agent in their own care environments by providing on-site trainings. This approach empowers the facilitators and learners to link their new knowledge to real examples, familiar to them in their current work and co-constructs their learning experiences. Various interactive strategies, such as sharing, case discussion, role play, reflection and debriefing, were adopted to promote situated learning. In addition, the programme adopts an inclusive approach, in which all staff members in the care settings – not only those involved in the direct care of people with dementia – were invited to be learners. Stigmatisation and misunderstanding about dementia exist in this society, and this programme aims to raise the awareness towards dementia among non-care-related staff. The inclusion of all staff members in the training laid an important foundation in cultivating an atmosphere of caring and mutual understanding in the care settings.

To our best knowledge, this programme is the largest project amongst the Chinese communities to build staff capacity for dementia care across aged care services through a systematic and extensive manner. A mixed-method study was conducted to evaluate the effects of the training programme. The findings provided evidence that the improvement amongst learners throughout this three-year programme was not merely based on their knowledge related to dementia but also on the staff's attitude and sense of competence in dementia care. The reflective essay submitted at the end of the programme reveals that the learners gained an enhanced understanding of the behaviours and emotions of people with dementia. Over time, the care staff developed confidence in communicating with their clients or tailoring activities based on a person-centred care philosophy. The staff also achieved improvements in their collegial relationship and teamwork through regular peer learning activities embedded in the training. The experiences from this project suggested that the Train-the-Trainer approach connotes the need for organisational support for change. Therefore, the approach is an effective strategy for transferring knowledge and skills to different staff levels, fostering a positive care culture and enhancing the sustainability of change in the organisation.

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賽馬會耆智園 Jockey Club Centre for Positive Ageing

Professor Timothy Kwok
Director
Jockey Club Centre for Positive Ageing (JCCPA)
Tel: +852 2636 6323
info@jccpa.org.hk
https://jccpa.org.hk/
www.facebook.com/jccpahk

Funding health research: The Canadian Institutes of Health Research

The role of the Canadian Institutes of Health Research, when it comes to funding health research in Canada, is explored here, including a look at the work of the Human Development, Child and Youth Health division within that

The Canadian Institutes of Health Research (CIHR) is the federal funding agency for health research in Canada. It is made up of 13 Institutes and as such, collaborates with researchers and partners to support the innovations and discoveries that improve health and strengthen the country's healthcare system.[1]

We know that the CIHR invests approximately $1 billion every year in support of health research. This funding supports excellence across all four pillars of health research: clinical, biomedical, health systems services plus population health. Certainly, each of the 13 Institutes is headed up by a Scientific Director.[2]

The CIHR mandate for research

As the CIHR Act from 2000 states, their mandate is very clear. Certainly, the CIHR aims to: "excel, according to internationally accepted standards of scientific excellence, in the creation of new knowledge and its translation into improved health for Canadians, more effective health services and products and a strengthened Canadian healthcare system."

This can be achieved in several ways, including the following:

- Showing leadership within the Canadian research community and encouraging collaboration with the provinces, organisations and researchers in or outside the country who are interested in health or health research;

- Creating a robust research environment for health in the country, based on internationally accepted standards of a peer review process and scientific excellence, to develop, attract and retain excellent researchers and provide them with the chance to contribute to improving the health of people in Canada and beyond;

- Forging an integrated health research agenda across sectors, disciplines and regions that reflects the emerging health needs of people and the evolving health system of the country. It is important to note here that supporting health policy decision-making is also important;

- Encouraging integrative, interdisciplinary health research through Health Research Institutes;

- Addressing emerging health opportunities, threats and challenges and accelerating the discovery of treatments, cures and healthcare improvements to healthcare, as well as wellness and prevention strategies;

- Providing support for and pursuing opportunities in terms of Canadian scientists taking part in health research partnerships and international collaboration and;

- Ensuring accountability and transparency to Canadians when it comes to the investment of the Government of Canada in health research.[3]

Human Development, Child and Youth Health (IHDCYH)

This article will now focus on just one of those 13 Institutes, Human Development, Child and Youth Health (CIHR-IHDCYH), which is headed up by Dr Shoo Lee from the University of Toronto. He is also Paediatrician-in-Chief and Director of the Maternal-Infant Care (MICare) Research Centre at Mount Sinai Hospital and is Senior Clinician Scientist at the Lunenfeld-Tannenbaum

Research Institute. Certainly, as the founder and Director of the Canadian Neonatal NetworkTM and the International Neonatal Collaboration, he very much believes in fostering collaborative research and as such, heads up the CIHR Team in the field of maternal-infant care. We read more about his excellent research work on the CIHR website: "His research focuses on improving quality of care, patient outcomes and health care services delivery. He developed the Family Integrated Care (FICare) model and piloted the concept at Mount Sinai Hospital.[4]

"The Institute of Human Development, Child and Youth Health (IHDCYH) funds health research to support and develop a well-trained base of investigators with the expertise and skills needed to design and conduct diverse and innovative and research plus knowledge translation targeted at improving health."

In a message from Dr Shoo Lee for World Prematurity Day and National Child Day in November 2018, he provides a flavour of his thoughts on how the CIHR-funded researchers are making a difference in the lives of Canadian people:

"The CIHR-IHDCYH is devoted to supporting research that gives children the healthiest possible start to life. We are committed to doing so in collaboration with our fellow Institutes and partners in Canada and abroad."[5]

CIHR-IHDCYH funds health research to support and develop a well-trained base of investigators with the expertise and skills needed to design and conduct diverse and innovative and research plus knowledge translation targeted at improving health.

Looking ahead, the beginning of 2019 was the time when we entered the last year of Dr Shoo Lee's second term as Scientific Director of the CIHR Institute of the CIHR-IHDCYH. In a written message from Dr Shoo K. Lee in February 2019, we discover that he will complete his term on December 31st, 2019 and his team at Sinai Health System has already begun the transition process. He emphasises that the CIHR-IHDCYH will continue to work with the CIHR staff and partners to deliver on the priorities outlined in the refreshed strategic plan, Healthy Foundations of Life: CIHR-IHDCYH Refreshed Strategic Plan 2018–2020[6]. At the same time, the CIHR-IHDCYH will ensure an orderly and smooth and transition to the next Scientific Director. Dr Shoo K. Lee then provides his reflections on his time in his current position as Scientific Director of the CIHR-IHDCYH.

"I am honoured to have served as Scientific Director of CIHR-IHDCYH for almost eight years. It has been a pleasure for me and my team to collaborate with our community to support research and capacity building in maternal, reproductive, child and youth health. I am confident that our efforts will make a long-term contribution to improving the health of families in Canada."[7]

Closing thoughts

A further example of the kind of research that the CIHR-IHDCYH fund concerns that which strengthens Canada's capacity and knowledge by supporting a new generation of reproductive, maternal, child and youth health researchers. Certainly, this is achieved by providing vital training, mentorship support and early career development to researchers in these fields. We know that the CIHR-IHDCYH embeds capacity development and networks for mentorship and support of trainees into each of the programmes that it funds.[8] This and other examples certainly fit in well with the CIHR's wider aim to support excellence across all areas of health research and that strengthen the Canadian healthcare system and improve the health of the country's inhabitants.[9] ■

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Funding obesity research in the U.S. today

Here, we find out about the role that the National Institute of Environmental Health Sciences, a publicly-funded institute, when it comes to funding obesity research in the U.S. today

The National Institute of Environmental Health Sciences (NIEHS), part of the National Institutes of Health, makes use of technology and state-of-the-art science to find out the interplay between environmental exposures, human biology, genetics and common diseases to help improve human health and prevent disease. The NIEHS is dedicated to carrying out the most rigorous research in the environmental health sciences and to communicating this to the public, in the organisation's capacity as a publicly-funded institute. [1]

On the website of the NIEHS, we find out that millions of people in the United States (U.S.) and globally are obese or overweight. Certainly, obesity is said to be a complex health disorder that affects people of all ages. For example, in the U.S., childhood obesity is a serious problem. Simply put, obesity means that one has too much body fat and it occurs over time when we consume more calories than we use.

One really important point is that being obese puts people at risk for many other health problems, such as arthritis, diabetes, stroke, heart disease, breathing problems and some cancers. Factors that contribute to obesity include one's family history and genetics, metabolism, environment and behaviour or habits, for example. [2]

Today, scientists are starting to look into the notion that some chemicals in the environment could play a part in the growing obesity problem. Examples of chemicals that may be obesogens include cigarette smoke, air pollution, flame retardants, Bisphenol A, some pesticides and polychlorinated biphenyls used in paints, types of cement, fluorescent light ballasts, sealants and adhesives. [3]

While obesity is indeed a serious issue, it's not all doom and gloom. Certainly, we know that even modest weight loss can prevent or improve many of the health problems associated with obesity. Increased physical activity and behaviour changes, as well as dietary changes, are all factors that can assist people to lose weight.

Staying in this positive mindset, let's look at some examples of NIEHS funded research in the field. In March this year, we discover that vitamin D may be protective among asthmatic obese children dwelling in urban environments with high indoor air pollution. This study from Johns Hopkins University School of Medicine was published in The Journal of Allergy and Clinical Immunology: In Practice.

"What surprised us the most was that the findings of the study showed the effects were most pronounced among obese children," said Sonali Bose, MD, Lead Author. "This highlights a third factor at play here – the obesity epidemic – and helps bring that risk to light when considering individual susceptibility to asthma," she added. [4]

Another example of NIEHS funded research in the field can be found from March this year when we learn about an international study led by USC scientists, which tells us that toddlers with asthma are more likely to become obese children. This is the largest such study and focused on no less than 20,000 young people throughout Europe. Beyond wheezing and shortness of breath, the study said that asthma can lead to bodies that make young people more vulnerable to other health problems when they are older.

Lida Chatzi, Senior Author and Professor of Preventive

Medicine at USC, believes that asthma and obesity raise a serious concern about a public health crisis. "We care about this issue because asthma affects approximately 6.5 million children – about one in 10 – in the U.S.," Chatzi said. "It's a chronic childhood disorder and if it increases the risk of obesity, we can advise parents and physicians on how to treat it and intervene to help young children grow up to enjoy healthy, adult lives." [5]

As this article draws to a close, let's briefly examine another study by scientists at the NIH and their collaborators, which discovered that young women with high body fat have a lower chance of developing breast cancer prior to menopause. This could help researchers to understand the role obesity plays in breast cancer risk better.

"Our finding that breast cancer risk is not increased in obese premenopausal women, and in fact decreases, points to the possibility that different biologic mechanisms are responsible for causing breast cancer in younger women," said Dale Sandler, PhD, Co-Senior Author and Head of the Epidemiology Branch at the NIEHS.

NIEHS Staff Scientist, Katie O'Brien, PhD, who works in Sandler's group commented that this work is a great example of how scientists can pool their resources to tackle important research questions in greater detail. Certainly, the examples in this article show how research into obesity is being supported in the U.S. today. "We hope this is the first of many studies to specifically focus on risk factors for breast cancer among young women," she underlines. [6]

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Beyond the current obesity epidemic

Obesity is a growing problem around the world, with many negative consequences for both individuals and societies. Research by Professor Barry M. Popkin and his colleagues at the University of North Carolina (UNC) aims to lead us beyond the current obesity epidemic

Holding a PhD in economics, Barry M. Popkin, PhD, is the W. R. Kenan, Jr., Distinguished Professor of Nutrition at the University of North Carolina at Chapel Hill, established the Division of Nutritional Epidemiology at UNC (since integrated into the dept) and later established and ran the UNC Interdisciplinary Obesity Center funded by the National Institutes of Health (NIH) with several training grants linked to it. He developed the concept of the Nutrition Transition, the dynamic shifts in our environment and how they affect dietary intake, physical activity patterns, and trends in obesity and other nutrition-related noncommunicable diseases (NR NCDs). Theirs was the first research on the double burden of malnutrition at the household level.

The Nutrition Transition can be thought of as the different stages a population goes through as its access to food evolves from hunter-gatherer to the future stage with a society with a health-oriented enviroment where increased activity and a healthy diet are the norm. This change occurs at different times in different societies, but it follows a similar trajectory in each case and comprises five distinct stages. Beginning with hunter-gather, the stages transition to the fourth, which is dominated by receding families and NR NCDs. At that point, the population has easy access to foods that are rich in fat, salt, and sugar yet low in fibre and polyunsaturated oils and usually at the same time the population transitions to a sedentary lifestyle. An epidemic of obesity and the many associated health issues quickly results. The fifth stage – the behavioural change stage – marks the point at which people and governments strive to change the environment and subsequently lifestyles. Hundreds of papers by Popkin and other scholars show the dynamic shifts in diet and physical activity that have led the world's population to the current stage with high and increasing rates of obesity and other NR NCDs. He also published with Colleen Doak the first papers on the double burden of malnutrition.

Popkin's research program is globally focused to understand the stages of the Nutrition Transition and enables appropriate programs and policies to improve the health of the world's populations (see www.nutrans.org and also his global food research program). His investigations have placed obesity and its determinants and consequences centrally on the global stage. His early research and evaluation efforts have drawn attention to diet changes and reductions in physical activity and their roles in increased overweight/obesity risks.

Currently, he is actively involved in program and policy design and evaluation, including collaborative appraisals of the impact of the sugar-sweetened beverage (SSB) and non-essential food taxes with the National Institute of Public Health in Mexico and similar work on the impacts of an SSB tax and marketing and front

of package labelling controls with the Institute of Nutrition and Food Technology at the University of Chile. His work in these and 16 other countries started in the late 1990s and features journal issues generated at two Bellagio Conferences (Bellagio Conference 2001 & Bellagio Conference 2013). He conducts research in Mexico, Chile, South Africa, Peru, Brazil, Colombia, Jamaica, and Barbados with Shu Wen Ng and Lindsey Smith Taillie, nutrition faculty at UNC. Through his work and consultations with additional countries, he aims to develop large-scale tax and regulatory policies to foster healthier diets and prevent obesity and other NR NCDs.

In addition, Popkin founded three major cohort surveys, the China Health and Nutrition Survey (CHNS) 28 years)[1], the Cebu Longitudinal Health and Nutrition Survey (CLHNS) (38 years)[2], and the Russia Longitudinal Monitoring Survey (RLMS) (25 years)[3] continue to follow the original individuals and their families. Each survey has provided public free-access data for thousands of publications not only by Popkin and his collaborators in each country but also by tens of thousands of other scholars. The RLMS began when he was a member of the small G-7 team[4] which worked first with the former Soviet Union and later with the Russian Federation to enact a series of laws and provide grants and loans as part of an effort to try to help the transition from Communism.

Popkin's many major awards for his global contributions include the 2018 Obesity Society Atkinson-Stern Award for Distinguished Public Service; the 2018 American Heart Association Lifestyle and Cardiometabolic Health Council David Kritchevsky Memorial Lecture and Award; the 2016 World Obesity Federation Population Science and Public Health Award; the Chinese government's first award in 2015 for significant foreign contributions to Chinese nutrition; the 2015 Conrad A. Elvehjem Award for Public Service in Nutrition; the 2011 Gopalan Oration Award, the top nutrition prize in India; the 2011 Obesity Society Mickey Stunkard Lifetime Achievement Award; in 2010 elected a fellow of the Obesity Society; the 2010 United Kingdom Rank Prize for Science; the 2010 E. V. McCollum Lecturer for International Nutrition Award; the 1998 American Society of Nutrition Kellogg International Nutrition Research Award the 1992 UNC School of Public Health Bernard G. Greenberg Alumni Leadership Endowment Award; in 1965 elected a fellow of the Woodrow Wilson Foundation; and the 1965 Wisconsin King Christian IV Award for Civil Rights Contributions. He has chaired the dissertation committees of over 60 doctoral students at the Gillings School of Global Public Health and has served as principal investigator on grants totalling more than $165 million in direct costs, many funded by the NIH.

Zero countries have reduced the prevalence of overweight/obesity

Popkin is working globally with international organizations on studies of food system changes and obesity and with Tom Reardon in Latin America[5] and with David McShirley in sub-Saharan Africa. Popkin co-authored with Dr Meera Shekar the World Bank's forthcoming obesity strategy book.[6] These are only the recently published examples of his global work.

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Barry M. Popkin,
W. R. Kenan,
Jr. Distinguished Professor
Gillings School of Global Public Health
Tel: +1 (919) 962 6139
Fax: +1 (919) 445-0741
POPKIN@UNC.EDU
globalfoodresearchprogram.org
www.nutrans.org
www.twitter.com/GFRP_UNC

Cannabis products: Greater diversity, increased potency and the need for close monitoring

A recent report from the European Monitoring Centre for Drugs and Drug Addiction highlights a greater diversity of cannabis products, increased potency and the need for close monitoring of health effects

Cannabis products have become increasingly diverse in Europe and close monitoring of their potency and potential health effects is essential. These are among the conclusions of a recent report published by the European Union (EU) drugs agency (EMCDDA) to mark the International day against drug abuse and illicit trafficking on 26th June. The report — *Developments in the European cannabis market* — provides an overview of emerging and established cannabis products in Europe[1].

The report identifies a range of factors behind the current diversity of cannabis products, including policy developments, advances in production and extraction techniques and changing consumer preferences. The creation of legal recreational cannabis markets outside the EU is also noted as driving innovation in the development of new cannabis products, some of which are now appearing on the European market.

"The dynamic nature of the current cannabis market and the diversification of cannabis products available bring considerable challenges", says EMCDDA Director Alexis Goosdeel. "New and more potent cannabis products may have serious public health consequences for users. Therefore, monitoring and understanding new trends in cannabis products available to European consumers today is important to inform the policy and regulatory debate."

Cannabis remains the most widely used illicit drug in Europe. Some 17.5 million young Europeans (15–34 years) are estimated to have used cannabis in the last year (EU-28). Around 1% of adults (15–64 years) in the EU are estimated to be daily, or almost daily, cannabis users. In 2017, some 155,000 people entered drug treatment in Europe for problems related to this drug, of those around 83,000 were entering treatment for the first time. Cannabis is now the substance most often named by new entrants to specialist drug treatment services as their main reason for contact[2].

Cannabis contains many different chemicals, the best-known being Δ9-tetrahydrocannabinol (THC) — largely responsible for the intoxicating effects of cannabis — and cannabidiol (CBD).

What are the new products in the European cannabis market?

- **Concentrates:** These are made by extracting THC from the cannabis plant, often using heat and pressure or volatile solvents or gases. Advances in extraction techniques are yielding high potencies (70%–80% THC). Consuming concentrates can result in high THC exposure and potentially pose a greater risk of psychosis and dependence.

- **Edibles:** This is an umbrella term referring to foods (often sweets or liquids) containing THC and/or CBD. Adding cannabis products to foodstuffs results in slower onset and longer duration of effects than when smoking cannabis (thus dosing becomes important).

- **Synthetic cannabinoids:** These man-made chemical substances mimic the effects of cannabis but may be

far more potent. Some of these are sold as 'licit' replacements for cannabis, however, some are now controlled internationally and/or under national legislation. The first synthetic cannabinoid identified in Europe (JWH-018) was detected in 2008 in products branded as 'Spice[3]. Since then, more than 180 synthetic cannabinoids have been reported to the EMCDDA.

- **Cannabis-based medicinal and health-orientated products:** These include products manufactured to pharmaceutical standards for medicinal use and others with varied composition and descriptions. The report provides a brief overview of approved cannabis-based medicinal products (an EMCDDA in-depth analysis is also available)[4].

"New and more potent cannabis products may have serious public health consequences for users. Therefore, monitoring and understanding new trends in cannabis products available to European consumers today is important to inform the policy and regulatory debate."

Latest developments with established cannabis products

Along with the emerging products on the European cannabis market, there are also challenges arising with the more established forms of the drug. In broad terms, there are two main types of herbal cannabis on European markets: 'sinsemilla' or indoor-grown herbal cannabis produced within the EU and imported herbal cannabis. In addition to herbal cannabis, plant material is also used to produce cannabis resin. Morocco is the largest producer of resin available on the European drug market. Data provided by the EU Member States show that the THC concentration of cannabis products found in Europe over the last decade has increased, raising concerns about potential harms. The estimated mean potency of herbal cannabis doubled from 5% to 10% THC from 2006 to 2016 and cannabis resin potency increased from 8% to 17% THC.

Monitoring tools to capture cannabis market diversification

The report underlines the need to develop monitoring tools to capture information on these products and their health effects, at national and European level (particularly on cannabis concentrates). From a harm reduction perspective, it will also be advisable to monitor the concentration of CBD in cannabis products. Finally, having the ability to distinguish illicit cannabis products from cannabis-based medicinal products and unregulated CBD oils will be important for law enforcement in many jurisdictions.

Cannabis, controversies and challenges

The new report is one of several EMCDDA publications and services exploring some of the complex issues in the cannabis policy field. These include analyses of the medical use of cannabis, cannabis and driving[5] and an online alert service on the status and recent developments in cannabis policy[6]. ■

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European Monitoring Centre for Drugs and Drug Addiction (EMCDDA)
Tel: (351) 211 210 200
info@emcdda.europa.eu
press@emcdda.europa.eu
www.emcdda.europa.eu
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What dosage of CBD should you use?

Savage Cabbage Ltd offer their expert advice on what dosage CBD users should be taking and answers other often asked questions, in this in-depth article

There is no correct cannabidiol (CBD) dose, indeed, the optimal dose for the individual Consumer could depend on many factors, including CBD tolerance, body weight, the type of CBD product being taken, or its concentration. Basically, we are all different people with different needs with regards to the dosage of CBD, the method of finding your sweet spot is clearly a personal journey, using the guide below will and can help to establish this if you are using oil-based products.

As can clearly be seen, the isolate displays a bell-shaped response curve, whereby an increase in dosage results in an optimal phase followed by a drop-off effect, conversely the full-spectrum hemp displays a plateau phase and no drop-off.

You can read more here.

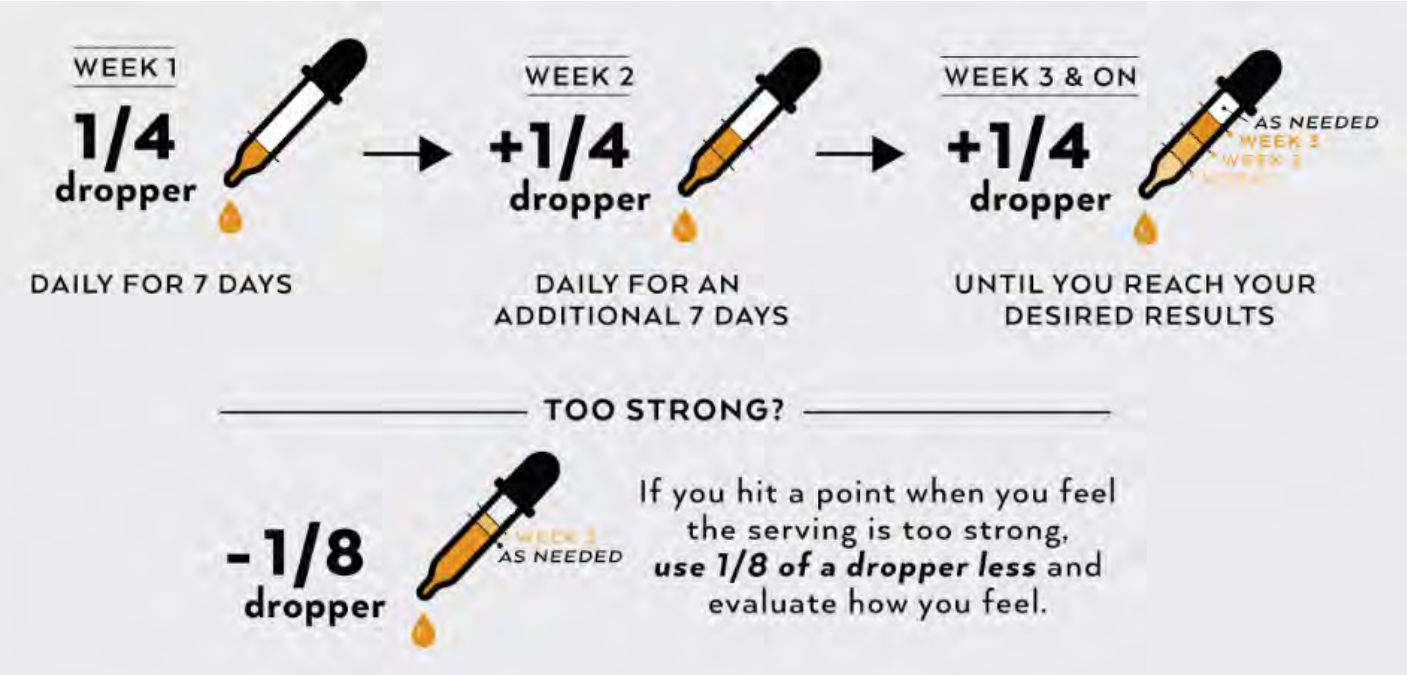
In our opinion, it is always wise to look for a whole plant hemp extract (full-spectrum) when researching a CBD product to use, although at savage-cabbageltd.com, we do stock a range of products to satisfy our customers' requirements, ranging from whole plant extract (full-spectrum) THC free (broad spectrum), isolate (only CBD) CBG or CBDA (we will discuss these products later).

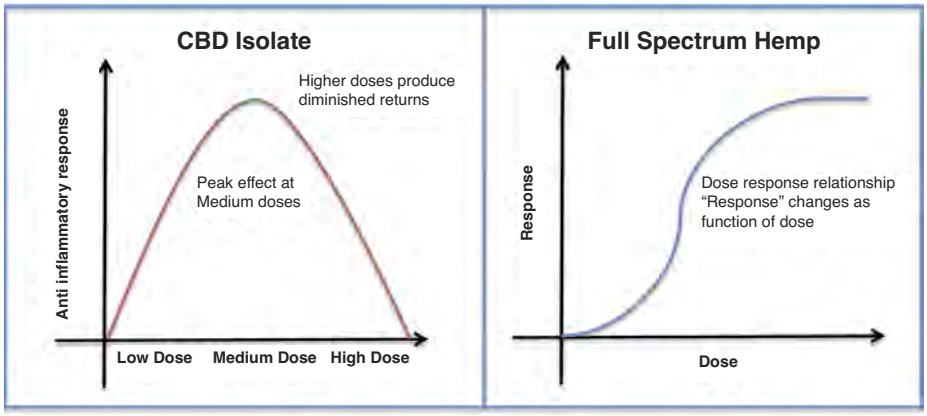
However, it has been evidenced through scientific research that full-spectrum hemp, which contains all the plants cannabinoid, terpenes and flavonoids etc, is far superior to a CBD isolate product.

The dose-response curves in the following schematic display the results discovered by Dr Stefan Kuprowsky BSc, MA Naturopathic – who endorses the importance of full-spectrum whole plant extract.

Can I overdose on CBD?

In a word no, because CBD is considered non-toxic and it produces few side effects but when they occur, they are typically minor. A recent report by the National Cancer Institute notes that overdosing on CBD is virtually impossible and the same is true for THC (Tetrahydrocannabinoid) because





cannabinoid receptors, unlike opioid receptors, are not located in the brainstem areas controlling respiration and lethal doses from cannabis and cannabinoids do not occur.

What is tolerance and what can I do to help deal with it?

CBD consumers may develop a tolerance over time, which can result in a reduced effect from the same dose. A method used by many of our customers to help deal with this situation is to stop taking their CBD product for 48 hours to give their endocannabinoid system a chance to reset and then start back on their sweet spot dose again. Conversely, some have reported that after a few months of taking their CBD product, they find that they don't need as much and manage to decrease their dose while maintaining the same effect, which you could describe as reverse tolerance, so to reiterate, we are all different people.

Some of our customers are reporting that they cycle between two or three different quality CBD products (for example, they spend two to three months on each product, in turn) as a means of controlling tolerance.

It's been suggested that as the plant is used for each different product, there will be a different strain and, therefore, the composition will slightly differ from one product to another. Here, the development of tolerance is not being experienced, although there is no science-based evidence currently available to endorse this, so feedback on this matter and methodology must carry some weight concerning tolerance.

These are the questions we asked when looking for a quality whole plant hemp extract to stock in our shop. The questions were asked as a consequence of Savage Cabbage CEO Jade Proudman undergoing a number of major operations which took their toll on her and we realised there was a need to enhance her wellbeing and improve her homeostasis.

We discovered that Charlotte's Web Oil is a full-spectrum hemp extract, more than just a CBD oil, with many beneficial compounds that come from their plants containing more than 80 other phytocompound including cannabidiol (CBD) cannabigerol (CBG) cannabichromene (CBC) along with terpenes and flavonoids.

Can body weight affect the dose I require?

Generally, a person's body weight plays a part in how little or how much CBD affects the body. As a rule of thumb, the heavier the person the higher the dose, conversely lighter people may feel the same benefit with a lower dose, but there is a factor that some individuals are more sensitive to CBD than others.

How do I get guidance or help with dosage? What if I am taking medication?

Only a qualified medical practitioner who is educated and has full knowledge of the CBD products available can give dosage advice (Good luck finding one in the UK). If you are taking medication and/or require guidance with CBD products, The Realm of Caring is the contact for free professional guidance. They are a charity based in the U.S. with a team of professionally trained individuals who will help with your enquiries and give guidance on a product and dosage. Or you could contact the United Patients Alliance.

https://www.upalliance.org

The United Patients Alliance support approximately 20,000 patients in the UK who are already successfully utilising cannabinoid therapy.

Established in July 2014, with the support of Professor David Nutt and Caroline Lucas MP, United Patients Alliance was founded to represent the interests of patients choosing to consume medical cannabis to treat their chronic conditions. With some of the most vulnerable members of society facing up to 14 years in prison, they call attention to the injustice of prosecuting individuals for consuming medicine legal elsewhere in the world.

Despite the wide body of clinical evidence supporting medical cannabis use and a change in Drug Policy in November 2018, moving cannabis to schedule 2, patients are still being denied safe access to a medication with a proven record of safety and

efficacy. The team at United Patients Alliance are all patients themselves with life- limiting conditions; cannabinoids have not only allowed them to elevate their own lives, but they now operate a platform that provides support to many thousands of people with unmet needs, providing tireless advocacy, community support, patient forums, educational tools and harm reduction advice nationwide.

United Patients Alliance have been commissioned to assist with the facilitation of Project Twenty21 as part of Drug Science's Medical Cannabis Working Group. The project seeks to deliver a trial model that will see that 20,000 patients are placed onto trials over the next 24 months.

Carly's Amnesty

Patients in the UK are currently in a very difficult position. Despite recent changes to the scheduling that has seen private clinics write prescriptions on a daily basis, those who can't afford to buy immunity from prosecution are still being criminalised for consuming medicine that has drastically changed their lives. With the NHS seemingly years away from embracing this new library of medicines, patients are living with a two-tier system; if you can afford it, you are a patient, if you cannot you are criminalised. "I am a criminal, only because I cannot afford to sustain my £1,500 a month private prescription," says Carly Barton, who has spearheaded a campaign to allow patients the rights to domestic cultivation while policy catches up.

This would mean that patients would be able to cultivate their own strains that are most suitable for them and often higher in the non-psychoactive cannabinoid CBD. If granted, patients would be able to avoid potentially dangerous products often sold by dealers. They would also remove themselves from being financially complicit in the criminal market.

"This is the VERY least we can do for these patients if the NHS is not prepared to advance access swiftly. These people have already been through so much, they have usually weaned off highly addictive pharmaceuticals in favour of a more suitable, natural treatment that works better for them. To have your wellness criminalised does not make any sense. We, as a country, need to answer this question: if patients are already benefiting in the meantime, do they deserve to live in fear of a kick through the door in the night?"

In a short few months, Carly's Amnesty has gained endorsements and support from all political parties as well as the Police Federation, the Police Foundation and Crime Com-

missioners across the country. It is on the agenda for discussion at the next Drugs Strategy Board meeting at the Home Office.

What does full-spectrum mean?

Full-spectrum CBD oil includes a wide range of cannabinoids present in the cannabis or hemp plant. Full-spectrum CBD also contains a variety of essential vitamins, minerals, fatty acids, protein, chlorophyll, terpenes and flavonoids.

What does broad spectrum mean?

Broad-spectrum CBD is full-spectrum CBD without any THC. It offers all the entourage benefits associated with full-spectrum CBD, without any chances of THC being ingested into the body. Broad-spectrum CBD is an excellent choice for individuals that can't have any traces of THC is their system. However, it must be noted that in some products there may be a trace of THC.

What does isolate mean?

CBD isolate contains only CBD All the plant matter contained in the hemp plant, including oils, waxes, chlorophyll and more are removed, offering a finished product that's CBD and nothing more.

What is CBDA (Cannabidiolic acid)?

CBD has largely been viewed as the most promising of the cannabinoids for enhancing your health and wellbeing and medicinal research and as such, CBDA was overlooked, however, the new trend in raw juicing cannabis leaves has reignited the interest in CBDA. To view MYRIAM'S HOPE THC FREE DAILY 25 CBD 30ML, please visit this link.

CBDA is the precursor for CBD, CBDA is found in the raw plant material and is the acidic precursor to active CBD. Both CBDA and CBD first develop in the plants as cannabinoid cannabigerol (CBGA) once an available enzyme is present, CBDA synthase, it converts CBGA to CBDA. From here, CBD is formed from CBDA via the process of decarboxylation, which involves applying heat to remove the carboxyl group. The decarboxylation can also happen during vaporising, cooking and during the drying process of the plant matter.

What are the benefits of CBDA?

Research has suggested that CBDA has the potential for pain relief, reducing inflammation, as an appetite suppressant, reducing seizures, promoting bone growth and inhibiting cancer cell growth. However, no clinical trials have been carried out as yet and more research is needed as CBDA is much more than the inert cannabinoid that the scientist originally thought. You can find out more here.

What is CBG (Cannabigerol)?

CBG is the non-acidic form CBGA and GBGA is the parent molecule from which several additional cannabinoids are produced. Once the plant is fully matured, the majority of the CBG within the plant is already converted into CBGA which turns into other cannabinoids. CBG is often described as the parent of other cannabinoids.

savage cabbage
HEMP • HEALTH • WELLNESS

Savage Cabbage Ltd
Tel: +44 (0)1751 471 491
info@savagecabbageltd.com
https://savagecabbageltd.com

Medical marijuana: Developments in the industry

Ian C Tordoff, CEO of Block Commodities Ltd, provides a snap-shot of changes in the medical marijuana industry

The Block Commodities team has followed the development of the medical marijuana industry over a number of years. We had the good fortune initially to become involved with experienced U.S. cultivators and African licence holders for medical marijuana and our journey has become tied to a global transformation which has quietly gathered pace in the re-assessment of the value of marijuana from "users", to legislators to revenue collectors.

As a listed public company, we are highly regulated and our focus is on legal growth, processing, research and the sale of primarily CBD and THC products. Whilst our project started in Africa, we have also quickly acquired licences for research and two further areas for cultivation and growth in Europe and Africa, with re-investment of a percentage of profits in social and infrastructure projects. Our objective is to develop a high-quality growth, research and distribution network.

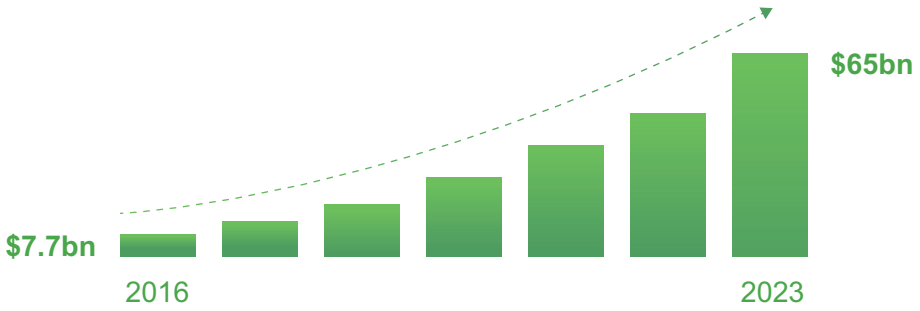
As with any industry sector, the global market can at first appear chaotic, however, un-picking the myriad legislative and regulatory requirements across Africa, Europe, Canada and the U.S., it is clear that established technical expertise, supply-lines, finance and supporting industries are established and continue to develop rapidly. Uruguay, Canada and Luxembourg have set a national legislative pace and in the U.S., 33 States have legalised the medicinal use of which eleven have endorsed recreational use. The collective legislative response in the European Union (EU) has been slower although, "the European Parliament has positioned itself in favour of legalising the therapeutic use of cannabis by approving a resolution urging the European Commission and all Member States to address the regulatory, financial and cultural barriers related to the plant." [A]

Whilst centralised policy remains undeveloped, it has become apparent in our engagements at a national level that Spain, Germany and Portugal are developing solid infrastructures with multiple licences for growth, processing research and export granted; the Dutch have superb quality growth capability, established analytics and labs; Denmark is building state of the art processing capacity and the Baltic State's crops are being harvested and processed. Malta, Switzerland, Poland and a number of States in the Adriatic have licenced growth and production at various stages of development. China, where the possession and use remain illegal, is pragmatically becoming a major volume producer of CDB and THC labs are already established by European businesses. However, for the moment, the commercial muscle remains in the U.S. and Canada, where consolidation is already becoming evident and applications to list on European exchanges are growing.

The World Health Organization (WHO) has recommended a rescheduling of Cannabis within the international drug control framework to facilitate trade for medicinal and scientific purposes re-aligning the 1961 and 1971 conventions. However, the Commission for Narcotic Drugs delayed its vote on the proposal earlier this year. In August meanwhile, The American Bar Association endorsed the ending of Marijuana Prohibition, urging Congress to end the conflict between State and Federal Law. [1]

While legislative and regulatory barriers continue to be asymmetric and porous consumer demand continues to outstrip supply and while this has a significant impact on the quality of product reaching consumers, it also risks criminalising consumers and inhibits the generation of tax revenues. This has been evident in the UK where evidence for the efficacy of plant-based treatments for alleviating the symptoms of diseases such as epilepsy, Alzheimer, arthritis, asthma, cancer or mental disorders such as psychosis are acknowledged [2] but existing clinical studies are considered insufficient. [3] Some parents of child suffers are risking prosecution to secure supplies from sources where treatments are legally available. [4]

The medical profession's response whether to THC or CBD based products is not unexpected, Harvard MD Peter Grimspoon on CBD says, "We



"According to data compiled by Mordor Intelligence, the global cannabis market was valued at $7.7 billion in 2016 and is expected to reach $65 billion by 2023. Additionally, the market is projected to register a robust CAGR of 37% during the forecast period as well" – Marketwatch, 22 Feb 2019

need more research but CBD may prove to be an option for managing anxiety, insomnia and chronic pain. Without sufficient high-quality evidence in human studies, we can't pinpoint effective doses and because CBD is currently mostly available as an unregulated supplement, it's difficult to know exactly what you are getting." [5]

At the same time in an adjacent Harvard function, a study on a cannabis-derived flavonoid as a treatment for pancreatic cancer with a 70% success rate in mice, has been announced as having a potential 'major impact' on cancer treatment in humans. [6]

Again, despite professional caution, a recent Gallup Poll found, "public support for legalising marijuana has surged, 86% of U.S. supporters of legal marijuana saying its medicinal benefits are a very important reason they support legalisation...also freeing up police resources to focus on other crimes... and generating tax revenue... re key reasons for their support." [7]

The groundswell in consumer demand is compelling with one in seven Americans saying they personally use cannabidiol (CBD) based products... [8]

According to data compiled by Mordor Intelligence, the global cannabis market will be worth $65 billion by 2023.

The Autonomous University of Barcelona (UAB) calculated the revenue that the Spanish Public Treasury would receive €3.3 billion ($3.71 billion) per year in taxes and social security contributions. A With the benefit of legalisation diminishing the black-market share to 15% of total demand.

Based on the Spanish population, a crude extrapolation to the EU population would create €37 billion revenues, enough to cover a couple of Brexits and if the whole European population is taken into account, the figure is €53 billion.

Demand is already evident and growing: we see our role as cultivators and innovators creating a quality supply for medical and therapeutic use. Block Commodities Limited has pivoted its agriculture business to medicinal cannabis and in the process has acquired an exceptional Board; a world-class scientific and academic community; seed-stock, experienced cultivators and an enviable network of partners, customers and investors. We are collectively focused on the challenges and successes to come.

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BLOCK COMMODITIES

Ian C Tordoff
CEO
Block Commodities Ltd
info@blockcommodities.com
www.blockcommodities.com

Cannabinoids and health – from supplements to medicines

GreenLight Medicines is a supplier of quality supplements and is an active MedCan research company

GreenLight, Supplements and Medicines

GreenLight was established in 2014 in Ireland with two subdivisions: [1] Greenlight Supplements Ltd manufactures and markets a range of FSAI compliant products including cannabidiol supplements in Europe, and [2] GreenLight Pharmaceuticals Ltd (trading as GreenLight Medicines), a biopharmaceutical company focused on the research and development of safe and effective plant based medicines. Though GreenLight specializes in phytocannabinoid supplement production and clinical development, it performs research on the potential health benefits of a wide range of plant based compounds. The company is based in Dublin, but has recently created a UK based subsidiary and has plans to expand into Europe.

This article overviews the clear distinctions between cannabis plant derived supplements and medical products informed by GreenLight's expert perspective in the field. Core topics include a summary of the current supplement and medical cannabis regulatory frameworks, a primer on the science behind the endocannabinoid system, and pharmacological considerations of both supplements and medicines. From the outset, it is important to clearly define each product and their regulatory conventions.

Cannabinoid Supplements

Cannabis-based products, or herein called cannabinoid supplements (i.e. products not authorised as medicines)

can be derived from the hemp plant, which contains less than 0.2% tetrahydrocannabinol (THC) and usually aims to provide cannabidiol (CBD) to the consumer. CBD based products are the predominant cannabinoid supplement available in Europe as ingestible oils or gums, topical creams or vaping liquids. All of these products can be made using CBD isolate or derived directly from raw plant materials to retain a 'full spectrum' of cannabis plant compounds which may act synergistically on the body's endocannabinoid system (described in a future Open Access Goverment publication). Recent clarifications on cannabis and its components have confirmed that cannabinoid extracts including CBD are considered novel foods across Europe.

Cannabinoid supplements are not considered the same as medical cannabis. These supplements have not been rigorously tested for any clinical benefit through safety and efficacy trials and their quality or risk/benefit profile has not been formally evaluated by regulatory authorities. Many products, including those from GreenLight Supplements, will however meet Good Manufacturing Practice standards to maintain a quality standard for consistent composition of the product. Additionally, GreenLight Supplements are distributed only via pharmacies with staff on hand to advise consumers on their suitability (in light of potential interaction with co-medications, overviewed later). Greenlight have produced learning materials for pharmacists needing to update their knowledge of over the counter cannabinoid food supplements. This supports pharmacists in advising consumers are advised about using food supplements in supporting healthy living alongside a balanced diet. Greenlight take great care to ensure that the consumer understands that cannabinoid food supplements are not intended to prevent, treat or cure any medical symptom or health condition. Current human trial data has not provided sufficient evidence that CBD supplements are able to alleviate chronic conditions.

Medical Cannabis

'Medical cannabis' (Medicinal cannabis, MedCan, or in the UK, cannabis based medical products (CBMP)) refers broadly to a range of products that contain active compounds either synthesized chemically, isolated from plant or raw preparations direct from cannabis plants.

Developments in breeding, growing, harvesting and storage of plants have enabled standardised granulated cannabis or oil extract preparations. These raw cannabis preparations can vary widely in the types and relative amounts of cannabinoids depending on the particular product or strain of plant, the significance of which is to provide a 'full spectrum' of potentially synergistic cannabinoids and terpenes which are absent in isolates.

These products have shown moderate clinical evidence of efficacy in conditions such as severe epilepsy, chronic pain and intractable nausea and vomiting. Evaluation is still ongoing to consider the risk benefit profiles of CBMPs in treating specific medical conditions.

In Europe, medicines must be authorised by either the European Medicines Agency (EMA) or by a national medical product regulator such as the Medicines and Healthcare products Regulatory Agency (MHRA) in the UK or the Health Products Regulatory Authority (HPRA) in Ireland. The European marketing authorisation process has steered medical cannabis products toward purified cannabinoid isolates which lend themselves toward standardised pharmaceutical manufacture and traditional clinical trials of safety, effectiveness and side effects. In the past decade, several countries in Europe have passed legislation to allow the prescription of medical cannabis, where there is evidence of benefit in particular indications and where there is no alternative treatment. In 2018 Ireland and UK also permitted medical use but access programmes and prescribing recommendations are only now being established, restricting uptake.

Clinical Evidence for Medical Cannabis use

The current best evidence of the medical benefits and safety of cannabis preparations comes from systematic reviews of clinical studies and gold-standard randomised controlled trials (RCTs). The strongest evidence to date of efficacy, albeit 'moderate' in nature, emerges from multiple sclerosis, cancer nausea and epilepsy clinical trials. These conditions are invariably cited in government reports from Ireland, UK, Europe and US as the most appropriate indications to target with medical cannabis. 'Moderate' evidence, as referred to in the definitive US National Academies of Sciences, engineering and Medicine (NASEM) 2017 report, describes 'several supportive findings from good to fair quality studies with few or no credible opposing findings'.

This conservative description clearly indicates limitations and important gaps which need to be addressed by

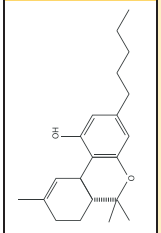
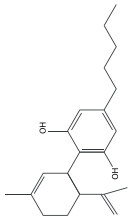
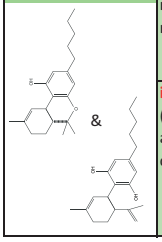
	Cannabinoid inhibits/ induces	Medications affected	Effect	Cannabinoid metabolised by	Causal medications	Effect
THC only 	**induces CYP1A2**	Amytriptyline, Clozapine, Chlorpromazine, Cyclorpromazine, Duloxetine, Haloperidol, Naproxen, Olanzapine, Warfarin	Overall increase in medication metabolism - decreases serum concentrations.	**CYP2C9** (breaks down THC)	Amiodarone, Cimetidine, Co-trimoxazole, Fuoxetine, Fluconazole, Fluvoxamine, Metronidazole, Sodium valproate	Overall reduction in THC metabolism, leading to higher serum THC concentration
				CYP2C19 (oxidises THC)	Topiramate	Overall reduction in THC metabolism, leading to higher serum THC concentration
CBD only 	**inhibits CYP2D6†** (metabolises antidepressants, antipsychotics, pain medication)	Selective serotoin reuptake inhibitors (SSRIs), Tricyclic antidepressants, Antipsychotics, Beta blockers and Opioids	Overall reduction in medication metabolism - increases serum concentrations			
	† NB CBD can interact with epilepsy medicines such as Clobazam, causing Clobazam serum levels to increase; concomitant treatment requires careful monitoring.					
THC and CBD 	**inhibits CYP3A4** (THC and CBD inhibit at higher concentrations; metabolises 25% of all medications)	Calcium channel blockers, Macrolides, Benzodiazapines, Antihistamine, Statins, Anti-retrovirals, Sildenafil, Haloperidol, Cyclosporine, Oestradiol, Progesterone	Overall reduction in medication metabolism - increases serum concentrations	**CYP3A4*** (breaks down THC and CBD)	Ketoconazole, Itraconazole, Ritonavir, Clarithromycin, Cyclosporine, Erythromucin, Verapamil, Sodium valproate	Overall reduction in CBD metabolism, leading to higher serum CBD concentration
	inhibits CYP2C family (blocked by both CBD and THC at low concentrations)	Repaglinide, Clecoxib, Warfarin, Lansoprazole, Omeprazole, Diclofenac, Ibuprofen, Naproxen, Diazepam, Citalopram		* NB Rifampacin, Carabamazepine, Phenytoin, Phenobarbitol and St. John's Wort can induce or amplify te CYP3A4 pathway, thus speeding up the metabolism/breakdown of THC or CBD		

Figure 1: An overview of known drug interactions with CBD and THC

larger, longer follow-up clinical trials which test alternate cannabinoid combinations, dosage and interactions with other medications. Additionally we can learn from previous clinical studies to take account of pharmaco-genetics (variation in how genetic different patients with the same condition will metabolise and respond to a particular drug) and comorbidities (co-existing conditions) to provide medical professionals with reliable evidence of efficacy for real world patient populations. Indeed, studies which test the efficacy of lesser studied cannabis plant isolates and standardised whole plant extracts could provide evidence of the often cited 'entourage effect' of multiple complementary cannabinoid and terpene compounds.

Expanding Medical Cannabis Research

GreenLight Pharmaceuticals Ltd. currently has 9 therapeutic research and development projects based across 3 core disease areas:

1. Cancers including prostate, ovarian and breast,

2. Neurological conditions including Alzheimer's, epilepsy, addiction and pain.

3. Inflammatory or immune related conditions including arthritis and arthritis-related depression, eye disease and diabetes (rationale showcased in greater detail below). They also have a plant-breeding project to optimize proprietary strains and a dedicated lab to purify and screen compound mixtures, prior to pre-clinical testing in each research programme.

GreenLight is conducting research on whether specific cannabinoids reduce inflammation and can reduce pain in arthritis. Cytokines are molecules produced by cells during tissue injury, swelling and repair, which can signal to other cells to become involved. Cytokines can moderate levels of inflammation and are generally found at higher levels in conditions such as arthritis, contributing to joint damage and ultimately disability. Current studies suggest that specific cannabinoids suppress inflamed states of the immune system, by increasing immunosup-

pressive cytokines and minimising T-cell activating cytokines. In doing so, cannabinoids may also reduce sensitisation of nerve endings to pain. Clinical trials conducted to date on cannabinoid treatments (usually with CBD: THC in combination) are inconclusive on whether they are effective in arthritis. It is likely there are a number of reasons for this, including the specific treatment composition, doses used, modes of delivery and poor trial design.

GreenLight plans on expanding its program of research into the anti-cancer potential of phytocannabinoids and other plant-based compounds. The company also plans phase II clinical trials of investigational medical products in both arthritic pain and epilepsy.

Pharmacological interactions of Cannabinoid Supplements and Medical Cannabis

As with many other supplements or foods such as St. John's Wort or grapefruit, some consideration should be given to potential for interactions with prescribed or non-prescribed medicines. Prior to prescribing cannabis for medical use, clinical guidance by the Irish Department of Health recommends conducting a full review of concomitant medicines and supplements. Particular care should be taken with sedatives, anti-spasticity agents and epilepsy medicines. Concomitant CBD for example can elevate blood levels of clobazam and its active metabolite in children with refractory epilepsy, necessitating close monitoring of clobazam levels. A summary of available drug interaction information is shown in Figure 1. THC and CBD also inhibit CYP2C family (cytochrome P450 liver enzymes involved in breakdown of drugs in the body) and CYP3A4 affecting the metabolism of a wide variety of co-medications. Conversely, several medications such as clarithromycin and sodium valproate inhibit THC and CBD metabolism by CYP3A4, thereby increasing cannabinoid blood levels.

MedCan prescribing recommendations

In line with prescribing for all medicines, the potential for harm must be weighed up against the potential for benefit for individual patients. Greenlight are supporting the education for pharmacists in prescribed medical cannabis, however the current guidance from regulators has been limited. The clearest clinical guidance on medical cannabis prescribing for MS spasticity, chemotherapy induced nausea and epilepsy has been provided by the Irish Department of Health. The document updated in April 2019 includes details on taking patient history, administration routes (vaporizer, oil products, oral/mucosal sprays), dosage advice, safety and withdrawal, contraindications and possible side effects. In the UK NICE will formally publish clinical guidelines for prescribing of CBMP's in November 2019. The NICE draft for consultation made available in August 2019 gives clear recommendations for which indications CBMPs should be considered and also flags research priorities. The guideline covers prescribing advice (and rationale and detailed evidence reviews behind each recommendation) for CBMPs in intractable nausea and vomiting, chronic pain, spasticity and treatment resistant epilepsy. A pertinent example is chronic pain, where use of THC in any form is not recommended and CBD may only be offered in a clinical trial. This conservative view is justified by the NICE committee, as current evidence indicates benefits of CBMPs in pain are only modest in nature, along with limited evidence of opioid sparing. Though the report acknowledges that the number of people suffering chronic pain who may benefit is large, the application of an (as yet undisclosed) economic model (to compare cost benefit with existing treatments) deemed potential benefits small relative to 'high, ongoing costs' and CBMPs 'were not an effective use of NHS resource'.

These reports raise important challenges that stakeholders need to address, foremost the need for valid scientific and clinical evidence to replace individual anecdote. This is particularly important where interactions with concomitant medications may be at play. GreenLight Medicines are passionate about tacking these knowledge gaps by rigorous research, with the ultimate goal of offering safe and cost effective products that have clear benefits for prescribers and end users.

GreenLight

David Gibson, PhD
Chief Scientific Officer
GreenLight Medicines (the trading name of GreenLight Pharmaceuticals Ltd)
david.gibson@greenlightmedicines.com
www.twitter.com/greenlightmeds

Access to medical cannabis and to what extent is medical cannabis now legalised?

Cosmo Feilding Mellen, Managing Director of Spectrum Therapeutics UK looks at access to medical cannabis and to what extent is medical cannabis now legalised

The world is reassessing cannabis. Today, over twenty countries across the globe have legalised the medical use of cannabis, with more recognising the potential benefits for the thousands of patients campaigning for access. Governments are playing a game of tug of war with one end cautious of the unknown, the other eager to unlock access. Here we will discuss current access to medicinal cannabis in the UK and the extent to which it has been legalised.

> "The consensus amongst experts is that more clinical trials in real patients are needed to understand the therapeutic benefits and potential risks of these medicines."

The change of law on November 1st, 2018 was a landmark day in England, Wales and Scotland with specialist clinicians listed on the General Medical Council's specialist register able to prescribe cannabis-based medicines for the first time, without the need to seek approval from an expert panel. However, at present, many patients and their families who saw that day as a glimmer of hope in their treatment journey, are still unable to access medicinal cannabis or face barriers even when eligible.

The issue of access has been largely attributed to the lack of knowledge and clinical evidence around medicinal cannabis, triggering reluctance amongst clinicians to prescribe these medicines. At present, there remains a limited number of randomised control trials for unlicensed cannabis-based medicinal products. This is partly due to the regulatory challenges of conducting research on Schedule I drugs, which cannabis was listed under prior to its rescheduling to Schedule II during November 2018. Medicinal cannabis is complex and physicians don't yet have all the information they need to confidently prescribe it to their patients as they do with other medicines. The consensus amongst experts is that more clinical trials in real patients are needed to understand the therapeutic benefits and potential risks of these medicines.

Additionally, guidelines published by NHS England and other professional associations are requesting further research into cannabis-based medicinal products until these associations will recommend them for use. This makes it difficult for clinicians to go against recommendations from their governing body. Many trusts are refusing to pay for treatment even if the patient holds a prescription from a specialist. NHS data suggests that 12 patients have received cannabis-based medicines since the change in the law last year.[1]

Despite this, the legal barriers to formally researching cannabis in a regulated setting are now changing and a future where eligible patients can have access to appropriately prescribed cannabis-based medicinal products is on the horizon. ■

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Cosmo Feilding Mellen
Managing Director
Spectrum Therapeutics UK
Tel: +44 (0)20 3817 6570
www.canopygrowth.com/international-footprint/spectrum-therapeutics-uk/
www.twitter.com/CanopyGrowth

The future for hemp: What is at stake?

Lorenza Romanese, Managing Director of the European Industrial Hemp Association (EIHA) examines the future of hemp and explains in this vein, what is at stake, as well as looking back at its fascinating history

Hemp has provided essential raw materials and a high protein and health-promoting food source for centuries, more likely millennia. The hemp plant has been used for construction, paper, textiles, ropes and other applications contributing significantly to the advance in western civilisation. Hemp was grown in Europe and most countries worldwide until the 1930s, after which cultivation got almost eradicated.

Since the end of the 20th century, hemp is making a comeback and is emerging as one of the most rapidly growing agricultural and industrial markets that have emerged for decades.

To clarify, we are talking about "hemp" (*Cannabis sativa L.*), which is authorised under the EU's Common Catalogue of Varieties of Agricultural Plant species (Reg. 1308/2013) and contains less than 0,2% of THC, which means it is not psychoactive.

The world is facing enormous challenges – how can we transition from high carbon to a low carbon economy? To achieve this, hemp has a valuable contribution to play and offers economically viable solutions to help address some of the major challenges our societies currently face, including pollution, carbon emissions, plastics waste, world hunger, people's health, lack of jobs and rural underdevelopment.

What are the key benefits of hemp?

The production of Hemp is *carbon negative*, which means it absorbs more carbon from the atmosphere during its growth than is emitted by the equipment used to harvest, process and transport it.

It is 10,000+ environmentally responsible industrial and consumer applications including bioplastics, composites, construction materials, high protein foods and beverages, health-promoting food supplements, textiles, paper products, biofuel, graphene substitutes.

It gives major environmental benefits. Significant carbon sequestration, enhanced biodiversity and a late season food source for bees, land reclamation and phytoremediation.

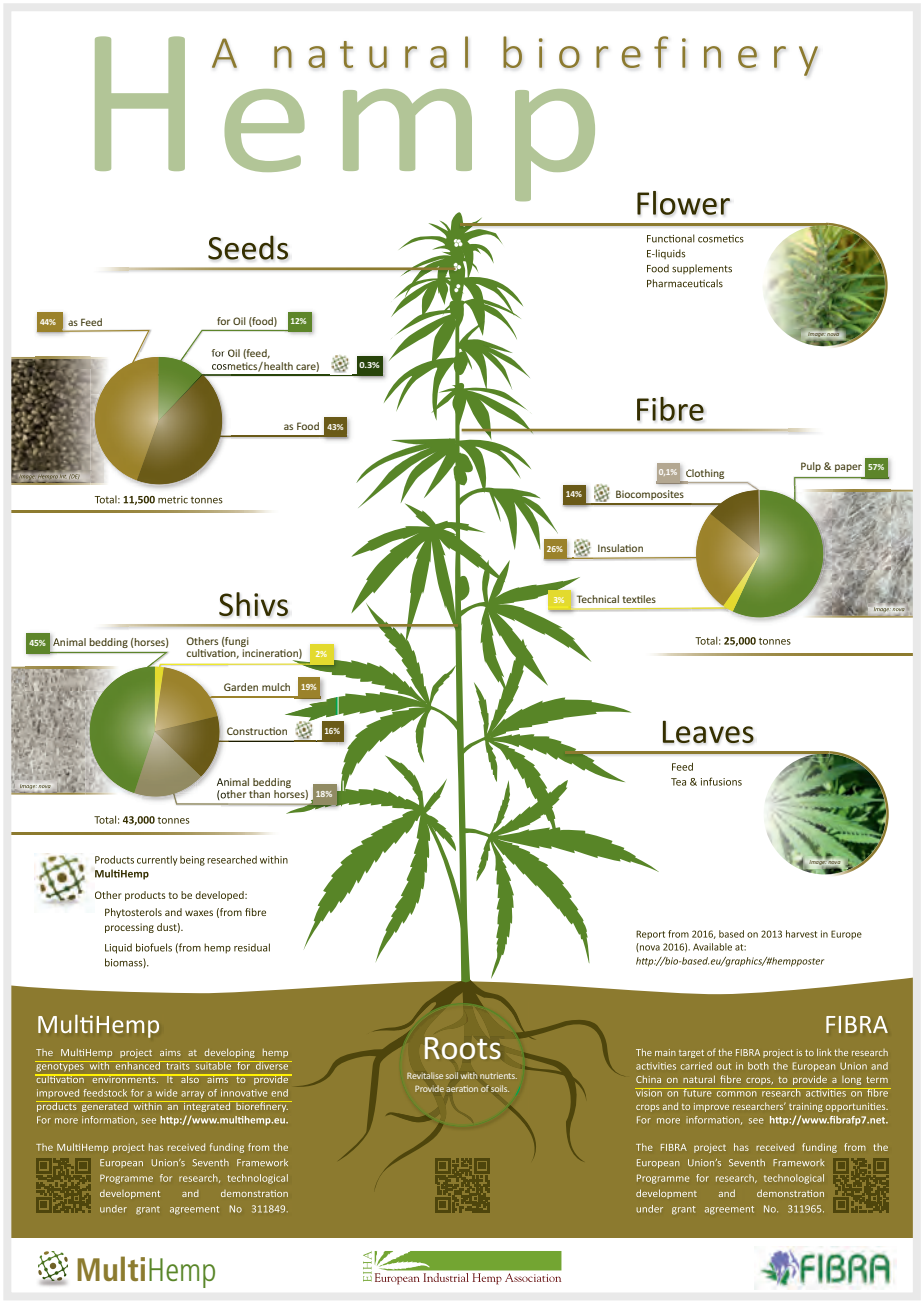
Also, hemp can be a profitable cash crop for farmers when permitted to utilise the whole plant.

What are the barriers to growth?

Almost 60 years ago, the hemp plant, which was widely used as food for centuries, was erroneously designated alongside the cannabis (marijuana) flower as a narcotic substance in the UN Single Convention. This has caused a lot of confusion as cultivation of cannabis plants for industrial purposes is clearly exempted from the scope of international control because the industrial hemp sector has been severely restricted in terms of onerous licensing procedures and unclear and complex European and national regulations dealing with hemp-derived food products.

Hemp foods and drinks from flowers leaves and extracts re-emerged in the 1990s. In response to the introduction of the Novel Food catalogue in 1997, the hemp industry collated data about the volume of sales and product types which use hemp flowers and leaves and submitted it as requested. In 1998, the hemp industry received written confirmation from the EU (PAFF Standing Committee) that: "it was decided that foods containing parts of the hemp plant do not fall under the EU Regulation EC258/97 on Novel Foods and Novel Food ingredients." The second letter from PAFF confirmed hemp flowers and leaves are food ingredients.

Hemp naturally, abundantly contains cannabinoids, is best known as cannabidiol (CBD). In the 21st century, awareness is rapidly increasing that consuming healthy foods and supplements can be an important



factor for our overall health and wellbeing. This prompted the introduction of hemp extracts in food supplements, commonly known as CBD oils. The reason hemp foods is so important to our health is that all humans and vertebrates have an important physiological system, the endocannabinoid system (ECS). The ECS fulfils a vital role and aids homeostasis. Whilst our body produces its own, so-called endocannabinoids, this is not necessarily sufficient and we can maintain and support this important physiological system by consuming phytocannabinoids, as we used to do for millennia.

Hemp flowers, leaves and extracts are a traditional food

Historical records show that naturally rich in CBD/cannabinoids hemp oils, flowers, leaves and hemp extracts were widely consumed. It was an integral part of our European diet.

During the last three years, the popularity of CBD containing food supplements prompted the PAFF committee to revisit the permitted consumption of hemp products and on 20th January 2019, the same committee that previously acknowledged in writing to the hemp industry 20 years earlier, that hemp flowers and leaves is a food now changed their minds and changed the Novel Food catalogue only permitting seeds for food use. Overnight the legitimate hemp foods industry was declared novel, meaning there is no history of consumption prior to May 1997.

In response, EIHA has prepared pieces of strong, extensive evidence that hemp cannabinoids/CBD have been consumed in Europe for centuries (insert a link to the evidence). One of the oldest cookbooks in the world, De Honesta et Voluptate (1475) lists a recipe on how to make modern-day CBD oil, medieval monks ate hemp soup, an Italian recipe (1887) shows how to make hemp flower tortellini, a Polish cookbook lists hemp as a vegetable, the Maltos-Cannabis Hemp Extract drink won a prize at the World Exhibition in Antwerp in 1894 and more. This evidence clearly shows that it is disingenuous to argue that leaves and flowers in food are novel today.


De Honesta et Voluptate (1475)

Hemp field

Why is the use of the hemp flower and leaves so important for the entire hemp industry?

The hemp flower and the leaves are the most profitable part of the plant. If the hemp sector is only allowed to use the seeds and stalks, alongside onerous licensing procedures, this is simply not sufficiently financially viable and undermines investment into R&D and the development of large- scale, next generation, environmentally responsible industrial and consumer products. The recent rewording of the Novel Food catalogue, therefore, threatens the entire European hemp industry as the process is expensive and a novel food application takes several years to assess.

Due to the fact that the hemp industry received written confirmation from the EU (PAFF Standing Committee) in 1998 that hemp flowers/leaves are permitted for food use and the hemp industry can provide ample and substantial evidence that naturally occurring CBD has been in the human food chain for millennia, we request that our extensive evidence is considered and that the novel food catalogue is reworded, permitting hemp foods containing cannabinoids/ CBD up to levels that are naturally present in the plant (which was the status in 2018). This means that CBD containing food supplements contain no more than we would naturally consume if eating traditional hemp foods.

So, what is at stake?

The Hemp plant is capable of helping to solve some of the core issues we face:

- Foods and supplements (seeds/ flowers/leaves) maintain and support our health.
- The stalk provides zero carbon raw materials ideal for the next generation of environmentally responsible applications, helping mitigate the environmental emergency.
- The hemp industry has a real opportunity to play a leading role in the development and expansion of a low carbon, environmentally responsible industry, bringing a new 'cash-crop' to European agriculture and creating jobs across the entire supply chain.
- For hemp to be a viable cash crop for our farmers and processors, they need to be empowered to utilise the whole plant.
- EIHA and its members offer our extensive knowledge and expertise to help establish a framework permitting the use of the whole plant that satisfies both regulatory agencies and industry.

"CBD has been found to be generally well tolerated with a good safety profile." *Excerpts from a letter of WHO Director General to Secretary-General of the United Nations, July 23, 2018*

"The Science Museum's three-storey building is constructed using a hemp-lime envelope and was so effective that they switched off all heating, cooling and humidity control for over a year, maintaining steadier conditions than in their traditionally equipped stores, reducing emissions while saving a huge amount of energy." *Dr Mike Lawrence is Director of the University of Bath's new research facility, the Building Research Park*

"It has been calculated that the serial implementation of the lightweight biomaterials on the high-volume vehicles will deliver a reduction of 40,000 tons of CO_2 emissions and the ability to drive an additional 325 million kilometres with the same quantity of fuel." *Source: Autocar Pro Newsdesk 3/2018.*

EIHA European Industrial Hemp Association

Lorenza Romanese
Managing Director
European Industrial Hemp Association (EIHA)
lorenza.romanese@eiha.org
www.eiha.org
www.twitter.com/EIHA16

Reviving the hemp market in the Central Asian steppes

Hemp Mongolia LLC reveals its implementation plan to build the largest hemp processing farm in the Central Asian steppes

Three years since research and intensive awareness efforts began dedicated to challenging prohibitive public barriers, our company has secured government authorisations and regulatory segregated individual licenses for the farming, processing, transportation, importing, exporting of hemp and its derivate by-product assortments, including CBD oil with its tremendously versatile industrial application potential.

Mongolia, a country best known in the ancient times as the cross route of the Silk Road, connecting trade between Europe and Asia and today, it is more visible in the eyes of international investors' eyes due to its vast mineral resources and untouched natural landscapes covering nomadic livestock grazing areas.

Our company's planned activities are focused on building a production facility plant logistically close to large agricultural farmland resources, including around 15,000 hectares of wild hemp fauna of prime genetically unmodified strains of both hemp and cannabis seeds. The fertile soil unexploited over the last 50 years has recently become an industrial-scale crop cultivation field.

However, the continental dry climate, prevailing meteorological conditions and relatively short cultivation seasonality factors have influenced the protection of the land from soil degradation and chemical contamination and helped to preserve the pristine qualities of hemp and have allowed the natural expansion of its growth area.

As the first company licensed in Mongolia to farm and process hemp – our team of investors, advisors and staff worked hard to build a consensus team of different public agencies representatives and convinced these cross-sectoral officers about the unique opportunities of Mongolia as a country with multilateral and cross-board trade facilitation agreements on a regional level – with our biggest trading partners and good neighbours being

the Russian Federation and People's Republic of China, as well as Singapore, South Korea, Japan and the European Union (EU). Also, our country is a Member State of the World Trade Organization (WTO) and an especially important agreement has been signed by the Mongolian Government with the Government of Japan that waives reciprocally export and sales taxes on traded goods.

To build a strong community for the professional exchange of news and media coverage provided by the opportunities opened up by the digital communications, Hemp Mongolia LLC aims to develop a strong and unified working group of NGO's consisting of hemp industry professionals representing countries in the Asian region, including India, Bhutan, Malaysia, Vietnam, Korea, Japan, Singapore so that that the hemp industry's latest product, technological market trends and trade flow developments can be followed by such working group members.

A.Anar's sums up the role of Asia in the hemp and cannabis sector in his own words: "Asia is moving in the hemp and cannabis sectors – the development is swifter following the oversight deregulations of industrially developed countries. This trend we follow may bring in the next round of significant ease in policy, inducing a potential hemp boom in the mid-term future. I believe the near future will determine Asia's marketplace as the price moving market force for hemp products due to its dominant consumption and volume demand.

Meanwhile, Hemp Mongolia LLC successfully accomplished its first open-air greenhouse hemp plantation trial and formed the first steps to add value in its technological and chemical property research and laboratory testing results assurances.

A.Anar then comments on this research in his own words: "This research and trial phase following the formalisation of the licensing regulatory requirements are an essential part of our work to study the previously undocumented and tested local seeds' genetic properties of local hemp. The improvement of selection and breeding is a big piece of work to carry out after the revealed findings and a result of the sampling and testing of the large variety of wild indigenous genetically preserved species originating in the vast regions of Mongolia, potential has been identified."

Phase 1:

The U.S. sales volume statistics are approximately $130 million. For CBD sales and the discussions around the legal framework regulations in the Asian region, I suggest that the CBD production is still relatively low compared to the existing and historically traceable demand volume of cultivated hemp harvest for medicinal usage. CBD oils are again becoming the centre point of international discussions as an alternative and effective,

naturally-low side effect carrying organic treatment for certain diseases and illnesses. Compared to the traditionally strictly standardised other agricultural farming cultures, hemp is not a cost-intensive crop culture with modest loss and unpretentious to climatic conditions.

The Mongolian climate has short cultivation periods and continental conditions and harsher climate leads to improvements in the chemical properties of hemp as a medicinal plant. Cannabinoid science is now in the starting phase to explore the medicinal properties of CBDA, CBN, CBG and CBC.

In summary, with this research and study trials of the Mongolian originated hemp cultures, I am sure that we will contribute to the development of the data bank of such scientific works and we will definitely be of an asset to the market of such R&D companies in the Asian region, as well as in the more industrially advanced countries.

Phase 2:

"Hemp Mongolia LLC's second stage is to build an extraction plant for CBD and other medicinal cannabinoids from hemp. The selection and on-site study of the latest extraction systems and building GMP compliant facilities in Mongolia is the main goal for developing and diversifying the export market based on the low-cost advantages of arable and cultivation land. Also, the plant facility land initial investment costs are attributed to the first industrial hemp processing plant licensed developer company. Already, during the beginning of our trial phase market, participants from Korea, Japan, Russian Federation, Germany and China have been approached with workable contacts and information exchange."

A.Anar notes: "Our company is confident in a production strategy based on the two sources of raw material available for the start of processing."

Firstly, wild hemp harvests, to be supplied for our production will bring in a relatively low material entry cost. The processing of wild hemp harvest will attract customers with a high awareness of a naturally and organically originated end product. The marketing and pricing of such pure organic hemp labelled products are commonly placed as high-end users preferred brands.

Secondly, assisted and advised by our company's partners in Spain, we will be providing selected and improved Mongolian strains based on newly cultured raw hemp materials on an industrial scale from in-house and out-door greenhouse plantations built on fertile virgin soil, without any industrial chemical contamination. Such outdoor open-air and indoor and outdoor greenhouse cultivation areas will be operated on with up to 15,000 hectares of good clean soil land leased from the government for at least 20 years and should be renewable for further periods.

"HempMongolia LLC is closely working

with and our activities are under the regulatory oversight of the Mongolian Government's respective agencies. Our company has invested major efforts since 2015 in early education, informing and awareness-building activities with public agencies. With an 'official' awareness of our company's activities, the benefits of hemp production and its exporting potentials are a large preparatory work to improve the regulatory relationships necessary to be licensed as the first company," A.Anar said.

A.Anar then develops this point further and recalls: "During the first discussions, officials were ignorant about hemp farming, due to a lack of information and industry and market-specific latest developments covered in the international media, but mainly due to the barriers of an old stigmatised approach to the hemp plant. So, we continuously provided scientific evidence and study to the agencies' responsible representatives, which could not ultimately afford to be ignored or overlooked simply due to the significant international trends in the regulatory environment. Presently, our company has been able to gain the support of the Ministry of Health, the Innovation Center, an agency under the auspice of the Mongolian Government Cabinet Administration and other governmental institutions."

Phase 3:

AGROPARK

Located after a two hours paved road drive east to Ulaanbaatar, Baganuur is a suburban city close to the capital of Mongolia. The Baganuur city is a special tax-free zone for industrial production factories, approved for new housing project developments supported and potentially to be financed by development agencies from the Mongolian government. HempMongolia LLC is studying the utilities and logistics, infrastructure connectivity and communication suitability requirements for building its production plant facilities in this city area.

Hemp Fibre, Hemp Food, Hemp Eco-Building Panels are some potentially profitable investment expansion areas for the environmentally friendly and green usage of Hemp industry investments. With the assistance of our advisor from Italy, Mrs Rachele Invernizzi is interested in the fibre and construction material domestic market, so our company will find investors for Mongolian company's projects willing to co-operate in the long-term with HempMongolia LLC to fill the gap in these areas of production, in particular, to offload the foreign exchange exposure of such importer companies and diversify their business to substitution materials manufacturing.

Our company sees good opportunities ahead to create market demand internally in Mongolia, as well as a comfortable foreign market environment for hemp growers and processing manufacturers and their sales agents. We are looking and willing to work to adopt the best international practices of hemp regulations and to assist and cooperate with Mongolian regulatory agencies.

Phase 4:

HempMongolia LLC sees a good future ahead when it comes to participating in Asian professional NGO's to become one of the best working teams to represent the countries vision for wellbeing and prosperity. With the digital age present in the daily life of each of us, our company believes blockchain technology and artificial intelligence (AI) will become the next facilitators for hemp value chain building participants.

HEMP Mongolia

Hemp Mongolia LLC

EU crackdown: Novel food regulation of CBD

Here, European Union (EU) Novel Food regulations are thoroughly explored and questioned in the context of CBD in food

The recent change in the Novel Food Catalogue, which is not a binding document, brought many negative consequences on the EU industrial hemp sector. Even if hemp extracts are not formally and legally forbidden by Europe, disproportionate and senseless measures have been taken against food products containing CBD in many European countries.

What does the change mean?

It means that this change in wording has turned the whole previously legitimate hemp extract and hemp (leaves/infructescense/flowers) supply into an industry that is now 'novel' and is required to apply for marketing authorisation prior to placing its products onto the market. This would be a long and very expensive process placing the entire EU hemp industry at risk. In addition, it is wholly unnecessary, illogical and illicit considering that:

A. The hemp industry received written confirmation from the EU in 1998 that hemp flowers/leaves are permitted for food use, and

B. Hemp has been in the human food chain for millennia and it is disingenuous to argue that leaves and flowers in food are novel.

1st version from 1998 till 2017	2nd version from 2017 to end of 2018	3rd version 20/01/2019
Only one entry for Cannabis Sativa L. (no entry for CBD or Cannabinoids)	One additional entry: Cannabidiol (CBD)	Both entries were changed: Cannabis Sativa L. and CBD
NF regulation is not applicable to MOST foods and food ingredients of this plant	Extracts of Cannabis sativa L. in which CBD levels are higher than the CBD level naturally present in the source Cannabis Sativa L. are novel	✔ Only seeds products and seed oil is now considered traditional (no NF application needed)
This entry reflected the PAFF decision of 1997 and was valid until…	Based on this definition, the hemp industry, made huge investments in the sector	✘ Food products made from leaves, flowers and all extracts containing cannabinoids are now considered as NF

Analysis of the various entries relating to Cannabis Sativa L (hemp), Cannabidiol (CBD) and the recent addition of a new category, Cannabinoids.

What can you extract from the plant?

Following any of the above four methods mentioned, you can obtain hemp extracts rich (but not unnaturally enriched) in CBD and other health supporting compounds. CBD is one of the 144 cannabinoids present in the hemp plant (mainly in the green parts of the plant). Consumers are buying CBD mainly for its health maintaining and supporting (promoting) properties.

Recent action by Member States and The Commission

On the 20 January 2019 the previous entries for "Cannabis sativa L." and for "Cannabidiol" were both rephrased.

When the NF directive (Regulation (EC) 258/97) became implemented in 1997, the Commission requested the hemp industry provide evidence of consumption which was collated by Hanfgesellschaft and submitted to the Commission for their consideration. In responses from February and March 1998, the Commission confirmed in letters to two FBOs that "hemp flowers... are considered to be food ingredients" and that "foods containing parts of the hemp plant do not fall under the scope of the Regulation (EC) 258/97" and a thriving hemp industry has since developed.

Below is an analysis of the various

entries relating to Cannabis Sativa L (hemp), Cannabidiol (CBD) and the recent addition of a new category, Cannabinoids.

What do the changes mean for the hemp industry?

According to the catalogue, all food/food supplements products containing hemp leaves/infructescence (tea, snacks, muesli etc) or containing hemp extracts now need to obtain a pre-marketing authorisation in order to being placed on the market. These authorisations are costly in terms of time as an authorisation process takes two years plus and significant amounts of money (€300,000+ per product). Only large operators and corporations will be able to afford the authorisation process. This way, Small and Medium Enterprises which mainly compose the EU market today, will be naturally left out of the market and alongside, this could potentially destroy the entire rapidly emerging and thriving European hemp industry.

If Europe will not allow FBOs to fully exploit the plant as a direct consequence the EU hemp sector will collapse in favour of other markets, such as US, Canada, Switzerland and China.

European Industial Hemp Association (EIHA.org) in cooperation with EU institutions are planning the next steps to be further developed with the aim to restore a regulation able to fulfil both scopes (part 1 point 2 of the NF regulation): protect the consumers and guarantee a smooth functioning of the internal market.

What else is at stake?

Hemp is emerging as one of the most rapidly growing agricultural and industrial markets in decades.

10,000+ applications including bioplastics, construction, high protein foods and beverages, food supplements, textiles, paper products, composites, biofuel, graphene substitutes

Major environmental benefits

- Carbon sequestration, enhanced biodiversity, land reclamation and phytoremediation, environmentally responsible industrial and consumer products

- Profitable cash crop for farmers when permitted to utilise the whole plant

- Plus multi-billion euro downstream markets

Key environmental benefits

Hemp protects the environment

Hemp can be grown without the use of herbicides, pesticides or fungicides. Hemp is in the top 5 out of 23 crops for biodiversity friendliness, performing better than all major crops such as wheat, maize or rapeseed.

Excellent carbon sequestration

One hectare of industrial hemp can absorb 15 tonnes of CO_2 per hectare. In comparison, agricultural land use emits approx. 3 tonnes CO_2 per hectare. Hemp's rapid growth also makes it one of the fastest CO_2-to-biomass conversion tools available, more efficient than agro-forestry.

Restores soil health

Hemp is a valuable preceding crop in rotations. After cultivation the soil is left in optimum condition.

Making one tonne of steel emits 1.46 tonnes of CO_2 and 198kg of CO_2 is emitted to make one tonne of reinforced concrete. One square metre of timber framed, hemp-lime wall, after allowing for the energy cost of transporting and assembling the materials actually stores 35.5kg of CO_2.

Body panels and chassis components in cars made from hemp are lighter weight than steel or metal which improves fuel consumption. Every bit of plastic, carpeting and upholstery in a car can be made of hemp.

For hemp to be a viable cash crop for our farmers and processors, they need to be empowered to utilise the entire plant.

The new Novel Food classification threatens the entire nascent environmentally friendly European hemp industry and we seek your support to raise awareness.

CBDepot.eu
Upmarket Cannabinoid Solutions

Michal Tozser
CBDepot
Tel: +421 911 920 888
michal@cbdepot.eu
www.cbdepot.eu

The cannabis industry in the UK: Risky business?

Is the cannabis industry in the UK a risky business? John Binns, Partner at BCL Solicitors LLP finds out more

Few can have failed by now to spot that cannabis and cannabis derivatives, are increasingly big business, not only in countries like Canada, but also right here in the UK. But the question of how this brave new world fits with the UK's institutional attitude towards cannabis is an important one and divides into domestic and international issues.

Taking the domestic first, those who grow, sell or do research on cannabis in the UK itself need to register with and obtain licences from a specialist Home Office unit, which is dealing at present with a very large number of applications and enquiries. Businesses that expect an easy ride from the unit, or to be able to deal with it on a commercial basis, can become frustrated with its processes and mind-set, which are – understandably, perhaps – particularly focused on the security aspects of what the law still considers a dangerous drug.

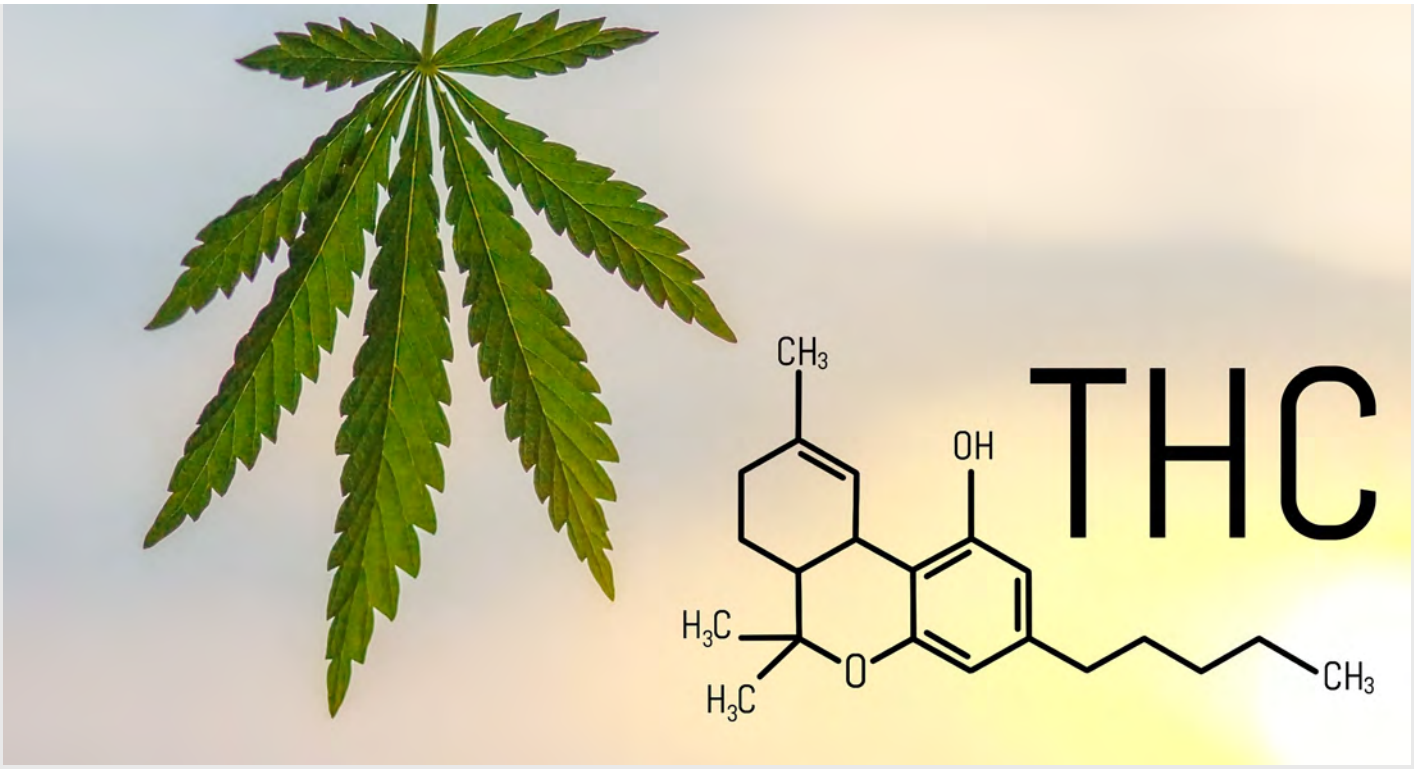
The casual observer could be forgiven for thinking that the position is more nuanced than it is, thanks to eye-catching headlines in autumn last year to the effect that medical cannabis had been legalised[1]. In fact, what has happened was that an exception has been made for 'cannabis-based medicinal products' (CBMPs), though only where prescribed by a specialist clinician (not just a general practitioner) or granted a marketing authorisation by the Medicines and Healthcare products Regulatory Agency (MHRA)[2]. Those restrictions have proved to be strict in practice and the headlines now are about why, despite the legal change, the number of patients who can actually access medicinal cannabis here remains extremely small[3] and patients who are forced to obtain their medicines abroad are still seeing them seized at the border[4].

Another common misconception is that cannabis, or cannabis products, with a THC level below 0.2% are

John Binns, Partner at BCL Solicitors LLP

straightforwardly legal in the UK. It arises because the threshold is relevant for various purposes in European Union (EU) legislation and other EU jurisdictions and in the UK plays a role in determining when the specialist licensing unit of the Home Office would be prepared to entertain applications for a cultivation licence (and what fees would be applicable for such licences). But where the question is whether a substance contains THC, so as to make it a controlled drug, it plays no role at all and the better legal view is that if there is any measurable THC content, the prohibition applies (subject, of course, to having a Home Office licence).[5]

That same question has also given rise to widespread confusion about CBD oils and other CBD products in the UK, which are increasingly ubiquitous on the high street. An MHRA statement in 2016[6], to the effect that it would treat CBD products that had medical purposes (a category that, in practice, largely depends on how they are marketed) as medicines, was widely misunderstood: while those few CBD products that are described in that way will need MHRA authorisation, the statement has no effect on the broader 'wellness' market, including food supplements, or on (say) cosmetics, or vaping products. Many who are not well versed in this area



may in fact be taking the risk of products being seized, premises raided, or personnel arrested.

The international issue, meanwhile, is that businesses planning to invest in cannabis overseas and then bring the proceeds here (or otherwise involve UK-incorporated entities), should also have UK money laundering laws in mind. Under the Proceeds of Crime Act 2002, it is an offence to do virtually anything with the proceeds of 'criminal conduct', which is defined to include conduct that is lawful overseas but that would be unlawful if it occurred here.

That does not necessarily mean that a UK investor in a Canadian cannabis company, for instance, is breaking the law by doing so. But there are judgement calls to be made about whether, when and how the investment should be reported to the National Crime Agency, with the aim of obtaining consent. Importantly, they are not made in isolation but alongside similar judgement calls by banks and others in the regulated sector, who have their own responsibilities to consider.

In the background of both sets of issues is the divide between medicinal and recreational use, as various jurisdictions consider where to draw their lines and the growing 'wellness' market blurs the divide still further. The UK, it seems, has some considerable way to go before even strictly medicinal cannabis is available to all who need it.

In time, perhaps, the UK may follow the example of Canada and others and adopt a more relaxed approach to cannabis. But for now at least, businesses that want to operate here must temper their enthusiasm by taking a proper look at their plans through a law enforcement lens and making sure they stay on the right side of the law as it is today.

John Binns is a partner in the business crime and corporate regulatory department of BCL Solicitors LLP in London (www.bcl.com), whose expertise includes the UK regulatory aspects of the cannabis industry. ■

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John Binns
Partner
BCL Solicitors LLP
Tel: +44 (0)20 7430 2277
jbinns@bcl.com
www.bcl.com

CBD by the numbers: Exciting new products on the market

John Wallace, Managing Director of Mile High Labs, International, shares with us why CBD continues to be one of the most exciting new products to hit the marketplace and focuses here on some significant numbers in the field

CBD continues to be one of the most exciting new products to hit the marketplace. From the offices at MHRA to the shops of the high street, policymakers, health practitioners, retailers and shoppers want to learn more about how this hemp-derived compound is created, processed and consumed.

To help understand this "mighty molecule," Mile High Labs offers the following information on CBD by the Numbers.

"The industry is growing, with potentially significant job creation on the horizon. In the past year, Mile High Labs has gone from opening its doors to having 11 full-time staff in its European headquarters in Belfast and a further nine in its London office and across the rest of the UK."

113

CBD is one of an estimated 113 cannabinoids that is found in the cannabis plant. Other cannabinoids include CBG, CBN, CBC and the more widely-known THC.[1]

All 113 cannabinoids can be found in both marijuana and hemp plants. What typically differentiates the two is the amount of THC content in the plant. Since the passage of the 2018 U.S. Farm Bill, the term "hemp" has been used to describe cannabis plants that contain 0.3% or less THC by dry weight.

Mile High Labs extracts exclusively from industrial hemp due to its low THC and high CBD content. The result is a line-up of compliant CBD ingredients fit for a rapidly growing number of global markets.

2018

The Agricultural Improvement Act of 2018,[2] more commonly known as the Farm Bill, legalised hemp production in the United States. It was this legislation that essentially jump-started CBD production in America and precipitated the global interest in the product.

That same year, the UK Government changed the law to allow doctors to prescribe cannabis under extremely limited circumstances, opening up the UK CBD market to rapid growth.

Authorities in the European Union (EU) Member States now regard food, drink and food supplements with CBD as a "novel food." A key regulation of novel foods is premarket authorisation which means any manufacturer intending to put CBD into food are required to apply to the European Commission.

14% & 41%

According to a Gallup poll, 14% of Americans use CBD. According to the report, "Younger Americans and those in the Western U.S. are most likely to report using these products, which are widely touted for their therapeutic benefits without any psychoactive effects because they contain a low level of THC."[3]

In May, Open Access Government reported that "41% of Londoners would use CBD to manage their mental health."[4]

And in early 2019, an analysis by UK-based online deals platform Wowcher revealed that purchases have almost doubled in the past year, with UK residents rushing to buy products containing the ingredient that is now used in copious health and beauty products.[5]

£1,000,000,000

According to a study by the Centre for Medical Cannabis (CMC), the market for CBD in the UK could be nearly £1 billion in six years.[6] Additionally, the report provides wide-ranging recommendations for industry success, including amending existing out-of-date legislation; clarity relating to current policy; investment in medical research; and self-regulation among current business operators. Many industry commentators and members of the CMC welcomed the report arguing that clear, consistent regulation is in the long-term interests of consumers and the industry alike, ensuring standards for consistency, quality and transparency.

7

The Association for Cannabinoid Industry, created by the CMC, recently announced "The Cannabinoid Industry Quality Charter," which is a seven-pillar framework to help foster a legally compliant, socially responsible and innovative CBD industry in the UK. Those pillars include a legal framework, testing, manufacturing, labelling, controlled drugs, marketing ethics and sustainability & social impact.[7] Mile High Labs is a leading member of the ACI and has previously worked closely with the Centre for Medicinal Cannabis in drafting and launching its reports.

9001

ISO 9001:2015 is an international standard for quality management systems for companies that operate in a regulatory environment.

The U.S. Food and Drug Administration currently does not have regulations in place for the production and packaging of dietary supplements or food containing CBD. As a result, the quality, consistency and purity of CBD products can vary significantly.

Instead of waiting for regulations, Mile High Labs have moved forward with "self-regulation" and earned certification for ISO 9001:2015, Good Manufacturing Practice (GMP) and other certifications to elevate the industry and give customers the confidence that their CBD is of the highest possible quality.

400,000

The square footage of Mile High Labs' new production facility is 400,000. Located near Denver, Colorado (the "Mile High City"), this former pharmaceutical plant allows the company to produce large quantities of tinctures, capsules, tablets, topicals and gummies in a controlled and compliant environment.

Mile High Labs CBD isolate is the key ingredient for some of the industry's most recognised products. With greater than 98% potency, our CBD isolate is extracted in a highly controlled environment and processed to guarantee industry-leading purity and consistency.

While some isolate manufacturers may claim over 99% potency, there is currently no regulation for the analytical testing methods that generate these results. Statistically speaking, there will always be variability in potency testing. But some companies that claim higher potencies are merely using less accurate testing methods that could bias the results high.

20

20 is the number of UK residents currently employed by Mile High Labs. With offices in London and Belfast, our team of sales experts stands ready to help customers learn more about the product.

The industry is growing, with potentially significant job creation on the horizon. In the past year, Mile High Labs has gone from opening its doors to having 11 full-time staff in its European headquarters in Belfast and a further nine in its London office and across the rest of the UK. The company also opened an office in Auckland, New Zealand with a further three full-time staff.

What does it all add up to?

One thing is clear: research and education are critical to the success of the burgeoning industry.

As the leader in the industry, Mile High Labs encourages stakeholders, retailers, and consumers to contact us to learn more. Give us a ring at +44 (0)28 9099 5253 or send us an email at hello@milehighlabs.com .

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MILE HIGH LABS™

John Wallace
Managing Director
Mile High Labs, International Limited
Tel: +44 (0)28 9099 5253
hello@milehighlabs.co.uk
milehighlabs.com
www.twitter.com/MileHighLabs

MariPharm: The world's first medicinal cannabis company

Here, General Manager Bart den Hertog, introduces MariPharm, the world's first medicinal cannabis business, highlighting the company's major milestone moments, its clinical trial process and recommended product dosage

The human body has a system of receptors controlled by cannabinoids. This can happen through cannabinoids that the body naturally produces itself (endo-cannabinoids) or through cannabis-cannabinoids such as CBD.

There are two types of cannabinoid receptors: CB1 and CB2 receptors. CB1 receptors are mainly in the brain and the central nervous system and CB2 receptors are mainly in the peripheral organs, and especially in the immune cells. Controlling the Human Endocannabinoid System plays an important role in maintaining overall good health.

What is CBD and is it safe?

CBD (cannabidiol) is one of the many active compounds in the marijuana plant. There are over 100 different compounds, know as 'cannabinoids'. The most well-known is compound is THC, the "psychoactive" component of cannabis that makes people feel 'high'. CBD is another cannabinoid which has very different and beneficial health and wellbeing effects, with scientists discovering more every day. The most important thing to know about CBD is that it is non-psychoactive and won't get you 'high'.

In a WHO report published in 2018, they stated that naturally occurring CBD is safe and well tolerated in humans. They concluded that there were no negative public health effects.

Who are MariPharm?

MariPharm is a ground-breaking Phyto-Pharmaceutical Company that produces the highest quality, pharmaceutical grade CBD oil in the world.

MariPharm was founded in the Netherlands in 1995 and for more than two decades has undertaken pioneering research into the cannabis plant. MariPharm was the first company worldwide to receive a government license to grow, research, process and sell Medicinal Grade Cannabis (MGC) which they exclusively provided to the public between 1995 and 2003. With over 30,000 patients having benefited from the use of MariPharm's MGC products, they have a wealth of knowledge in the use of cannabis, especially when relating to strains and genetics of the plant for different impacts and ailments.

Milestone moments in MariPharm's pioneering history:

1995 – MariPharm become the first company to receive a government license to grow, research, process and sell Medicinal Grade Cannabis.

1999 – The Royal Pharmaceutical Society of Great Britain invite MariPharm to the UK to discuss the therapeutic benefits of cannabinoids.

2002 – MariPharm break The Single Convention of New-York (1961) by exporting 1 Kilogram of MGC to the UK, licensed by the Dutch Ministry of Health Welfare and Sport.

2013 – MariPharm founder was granted a special benefit working license on medicinal cannabis from the Canadian authorities in order to consult for a large Canadian Medicinal Cannabis company.

2008-2017 – MariPharm's experienced team consulted on Medicinal Cannabis businesses around the globe. Countries include Israel, Czech Republic, Uruguay, U.S. and Canada.

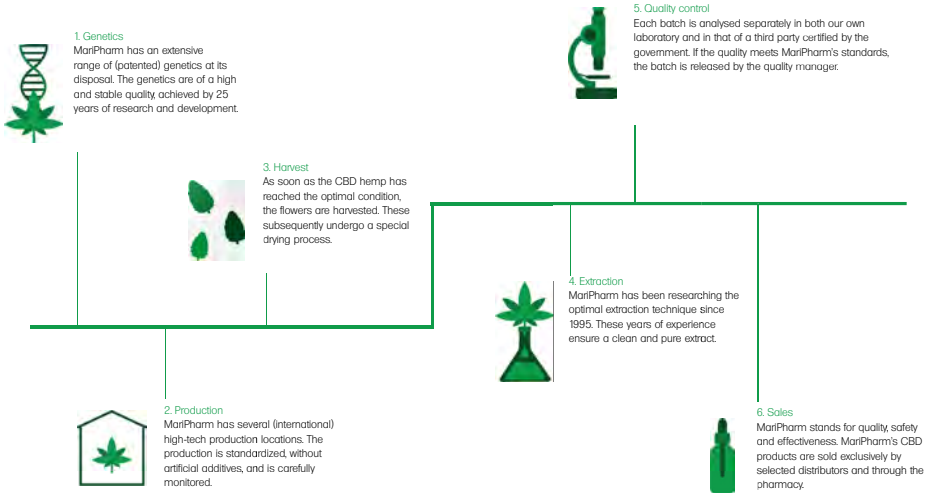
MariPharm has consistently used innovative technologies, developing a revolutionary extraction process for CBD oil that guarantees the highest quality product, formulated from MariPharm's unique patented genetics.

MariPharm maintains a state of the art manufacturing and grow facility with a dedicated high-tech laboratory – with third-party quality oversight and testing of each batch of product guaranteed by a renowned laboratory approved by the Dutch government to issue Certificates of Analysis.

MariPharm's quality and clinical trials

MariPharm products set the standard worldwide in producing and analysing cannabidiol with every batch going through stringent quality control measures to ensure the best quality product every time.

From seed to finished product



Years of painstaking research supported by leading scientists, pharmacists, doctors, and government specialists, backed by an Opium License from the Dutch Ministry of Health Welfare and Sport, have resulted in the world's finest quality CBD and cannabis derived products. MariPharm CBD oil is currently undergoing double-blind placebo and observational trails.

Seed to Sale

To ensure the highest quality standard of CBD products, MariPharm believes it is essential to engage with every step of the supply chain. From harvesting our seeds, laboratory testing for quality, to distributing our exceptional finished products (see image).

MariPharm products

MariPharm produces nutritional dietary food supplements and cosmetic products that can be purchased at various pharmacies and through the MariPharm online web shop across Europe.

MariPharm also holds Dutch Government permits and currently has several new ground-breaking CBD products under development that will be introduced in the very near future.

"I have been interested in the developments in the CBD sector for some time now and have seen for myself the effectiveness. However, not all CBD products are the same, so after trial and error, I now only use MariPharm in the clinic – I trust the brand implicitly." Dr Aamer Khan, Harley Street Skin Clinic

Colour, taste and aroma – What to look for in a high quality CBD oil

Purity and quality of CBD oil is recognised by the colour. CBD oils that appear brown, discoloured and sticky have undergone an incomplete extraction and purification process through which unnecessary and potentially harmful residues may remain.

Along with the colour of CBD oil, the flavour, taste and aroma of the CBD product also indicate how the production process has taken place. Some CBD products have a bitter taste or an unpleasant aftertaste, which can also indicate pollution.

The MariPharm extraction process produces a completely pure and transparent product which has a pleasant taste and a neutral aroma.

MariPharm CBD recommended dosage

Recommendations: Begin with three drops three times a day. The number of drops can be increased, if desired – always consult your doctor. It is recommended to administer the oil into the mouth sublingually by placing the drops directly under the tongue.

If the drops are administered directly under the tongue, the drops should be retained in your mouth for between 10-30 seconds before swallowing. In this way, the body immediately absorbs the active substance which provides rapid and optimal effects relative to the rate of absorption of active substances through the stomach.

For the best results and the highest level of absorption, it is recommend to take CBD five minutes after a meal (breakfast/lunch/dinner).

Mari Pharm®
Quality of Life

Bart den Hertog
General Manager
MariPharm B.V.
Tel: +31 (0) 85 130 14 74
info@maripharm.com
www.maripharm.com

The impact of cannabidiol on mainstream fast-moving consumer goods

Canna CBD Limited chart the impact of cannabidiol on mainstream fast-moving consumer goods, adopting custom from other lifestyle categories, such as alcohol, tobacco/vaping, cosmetics and health foods

It is without question that cannabinoid-based products have impacted the retail consumer goods market to a large extent in a short manner of time. During the past five years, CBD and other cannabinoid-based goods have gained a very large market share; adopting custom from other lifestyle categories, such as alcohol, tobacco/vaping, cosmetics and health foods.

Almost a year ago, in September 2018 According to Canada's BNN Bloomberg, the drinks giant Coca Cola began talks with Canadian producer Aurora Cannabis to begin developing cannabinoid-infused beverages. Showcasing how this industry has only just begun to be shaped by large corporations, who are bringing cannabidiol into the mainstream marketplace and retailers' shelves, "along with many others in the beverage industry, we are closely watching the growth of non-psychoactive cannabidiol as an ingredient in functional wellness beverages around the world," Coca-Cola said in a statement.

Constellation Brands in August 2018, showed their own interest, by vowing to invest over $4 billion into Canadian producers Canopy Growth, with $200 million spent on the research and development of a Cannabis-based alcoholic beverage utilising their Corona brand. Once again, showing that at this turning point within the cannabinoid industry, large corporations are focussed on bringing cannabidiol products to the mainstream aisles of supermarkets; and not the alternative health sections or stores – but a diverse range of mainstream products enhanced with cannabidiol.

To a lesser extent, Canna Investments – the Owner of Canna CBD and Green Coffee Lab, have positioned themselves to replicate these movements into the mainstream sector but on a more local scale within the UK marketplace. By utilising their own seed to shelf production capabilities, along with retail and marketing experience, Canna Investments has championed a unique approach to bringing new cannabinoid enhanced products to market via its own retail outlets positioned within the high streets of the UK and to an extent, in Europe and Asia. This approach offers an uncompromised view to education, product knowledge and expertise within the arena.

Canna CBD, the cannabinoid production arm of Canna Investments, was founded by Timothy Acton in 2017. Offering a range of typical CBD products, in the form of dropper bottles, sprays, cosmetics and oral syringes packed with full-spectrum extracts, as well as a fully-fledged white label programme offering over 50 clients production of their own branded cannabinoid products. Canna CBD in 2019, turned its focus to the production of mainstream consumer food products.

> "It is a fair assessment that cannabinoid enriched products are making a mark on various sectors within fast-moving consumer goods; and Canna Investments intends on pushing its own boundaries consecutively to provide its consumers, clients and associates the highest level of service, education and knowledge of this ever-shifting industry."

Opening its first branch of the Green Coffee Lab in May 2019, focussing on offering products incorporating the benefits of a cannabinoid enriched diet. Green Coffee Lab in its short inception has faced media acclaim, featuring in television programmes for BBC and ITV news. With its own hospitality department and hotel offerings, Green Coffee Lab has become one of the core factors in bringing Cannabinoid products to the forefront of consumers daily routines. Working closely with an Essex, UK-based brewery to expand its cannabinoid enriched alcohol offering.

It is apparent from market research, that cannabinoid-based products share a large consumer group with the alcohol market. A joint study by researchers at two U.S. universities and one in South America claims a reduction in the U.S.'s overall alcohol

Cannabinoid-based products have impacted the retail consumer goods market to a large extent in a short manner of time

consumption appears directly related to the rise of medical marijuana laws. Over the ten years studied, counties located in medical marijuana states showed almost a 15% reduction in monthly alcohol sales. Analysts at Cowen & Co., have illustrated the very real threat that cannabinoid enriched products have on the $1.2 trillion global alcohol market – quoting: "While recreational cannabis has only limited availability, the rise of cannabis consumption more broadly looks to be weighing on alcoholic beverage consumption, where it is now in decline for men and higher-income consumers."

This correlation of data has lead Canna Investments to focus more on the production of alcohol-based products, along with its line-up of food supplements due to this public perceptional shift on cannabis, cannabinoid-based products and how they interact with health at a social and lifestyle level. One of the core product line ups for the Green Coffee Lab has been its full spectrum enriched coffee beans; infused at the point of roasting for maximum effect. With single-point origin in Columbia, utilising the expertise of Master Baristas, Green Coffee Lab has produced a beautiful blend of full-spectrum CBD enhanced coffee beans for the retail market, allowing further accessibility to cannabinoid products and a new home for them on supermarket shelves. This thought process has continued into Green Coffee Labs subsidiary Leafy hotel – a hotel focussed on bringing cannabinoid accessibility, education and comfort to the forefront of its ethos. With terpene infused bed linen as a sleep aid and an array of CBD products on offer for guests to enjoy, such as shampoo, conditioner, tea, coffees and hot chocolate stocking the rooms. It is here, where Canna Investments has focussed its consumer research – utilising an array of customers from multiple backgrounds with its retail and hospitality sectors to glean data for its New Product Development machine. Utilising this newfound consumer research to develop further products such as variants of Canna CBD's oral sprays, vegan cosmetics and further enriched products.

In summary; it is a fair assessment that cannabinoid enriched products are making a mark on various sectors within fast-moving consumer goods; and Canna Investments intends on pushing its own boundaries consecutively to provide its consumers, clients and associates the highest level of service, education and knowledge of this ever-shifting industry.

Overall, Canna Investments, has various ambitions within the cannabinoid industry; ranging from construction and property development utilising its proprietary hempcrete methods, as well as agricultural development, coinciding with its already established nature as a production facility and retail division, with a keen vision and goal to achieve, we firmly believe there is room within the industry for a UK-based business to expand within the competitive marketplace.

You can discover more about Canna CBD at www.cannacbd.com or the Green Coffee Lab at www.greencoffee-lab.com.

CannaCBD

Canna CBD Limited
www.cannacbd.com

Cannabis-based medicines as a treatment for epilepsy in the UK

Sam Mountney, Senior Policy & Campaigns Officer at Epilepsy Action, shares his expertise on cannabis-based medicines as a treatment for epilepsy in the UK

Cannabis has continued to divide opinion since the government rescheduled cannabis-based medicines in November 2018, legally permitting them to be prescribed. Prior to this cannabis and cannabis derivatives were largely classified as schedule 1 controlled substances, with an associated narrative centred on prohibition, addiction and potential adverse health effects.

This law change has led to an increasingly informed and nuanced discussion focussed on the scientific facts and clinical evidence around the potential benefits of cannabis-based medicines to treat a number of long-term health conditions, including epilepsy.

For context, cannabis-based medicines is a blanket term for products containing cannabis or cannabis derivatives that are produced and regulated as medicinal products for humans.[1] As with most medicines, it is two active compounds present in the cannabis plant, specifically cannabidiol (CBD) and tetrahydrocannabinol (THC) that are of clinical significance and the current focus of debate.

CBD, a non-psychoactive cannabinoid, seems to be following in the footsteps of turmeric and aloe vera in its portrayal by some as the next holistic super supplement. In comparison THC, a psychoactive cannabinoid associated with the sensation of getting 'high' in the recreational context, continues to be viewed with caution.

There are a myriad of CBD products available as over the counter 'supplements' sold in health food shops across the country. These products are not of a pharmaceutical standard and by law cannot claim any medical benefits. They often contain very low quantities of CBD and have no notable clinical effects.

However, there is good quality clinical evidence for the safety and efficacy of CBD-containing medicine Epidyolex as an add-on treatment for two severe and life-limiting intractable epilepsy syndromes, Lennox-Gastaut and Dravet syndromes. This evidence is in the form of Randomised Controlled Trials (RCTs), the 'gold standard' of clinical evidence. The existence of positive RCT evidence has paved the way for Epidyolex to move towards UK market authorisation. It has already received market authorisation for these indications in the U.S.

The lack of such evidence for other cannabis-based medicines, particularly those containing both THC and CBD, is proving to be a critical stumbling block to access for people with epilepsy.

The powerful and compelling stories of Billy Caldwell and Alfie Dingley, two young boys with severe and treatment-resistant epilepsies, became front-page news in the UK last year and played a critical role in the change in the law. Both had been treated with cannabis-based medicines containing THC and CBD abroad and showed notable clinical improvements in seizure control and quality of life. Tireless campaigning by their mothers led to both children being prescribed medicine containing both THC and CBD on the NHS. They remain the only two NHS prescriptions of this type that we are aware of.

It is a bitter irony for many people affected by severe and treatment- resistant epilepsies that the very cannabis-based medicines that led to the change in the law are as inaccessible now as they were before. Despite THC's incarnation as a chemical bogeyman, many families of children affected by severe epilepsies are convinced that medicines with a 1:20 or 1:1 ratio of THC: CBD are the most effective. This is not without basis. Other G7 countries, most notably Canada and

Sam Mountney, Senior Policy & Campaigns Officer at Epilepsy Action

the United States, and European Union Member States such as the Netherlands, allow varying degrees of access to treatments containing both THC and CBD for epilepsy. In the Canadian example, the lack of RCT evidence is weighed against data from observational trials, pre-clinical studies and available evidence on the endocannabinoid system and epilepsy.[2]

Initial interim clinical guidance for both paediatric and adult epilepsies recommend against prescribing products containing THC and CBD in almost all circumstances. Recent draft guidance from the National Institute for Health and Care Excellence (NICE), which will ultimately supersede the interim guidance, indicates this is unlikely to change. A separate NICE technical appraisal process is ongoing in respect of Epidyolex to treat Lennox-Gastaut and Dravet syndrome and a decision is expected later in 2019.

Epilepsy Action is in complete agreement with clinicians, regulators, and the government about the need for more high-quality research. A recent NHS report[3] indicates the strongest commitment so far to move this research forward at pace. Commitments of political will and, crucially, funds for vital research are welcome, but they must be followed through.

Almost a year after the change in the law, patients remain unable to access cannabis-based medicines for epilepsy in all but a minority of cases and the debate continues. In one respect, the need for high-quality clinical evidence is a routine and necessary debate around access to medicines. In another, this debate is unique in trying to unpick decades of prohibition and instigating a battle between avid campaigners calling on compelling anecdotal evidence and international research to push for immediate access, and a UK regulatory system that will seemingly only accept the elusive gold standard RCT evidence.

> "CBD, a non-psychoactive cannabinoid, seems to be following in the footsteps of turmeric and aloe vera in its portrayal by some as the next holistic super supplement. In comparison THC, a psychoactive cannabinoid associated with the sensation of getting 'high' in the recreational context, continues to be viewed with caution."

Epilepsy Action is committed to ensuring people with epilepsy can access the best drugs at the right time. Though by no means a magic bullet, the hopes of many affected by severe and treatment-resistant epilepsies are firmly hung on cannabis-based medicines. Hope is often in short supply for these people and there is a clear need for a short-term solution to allow compassionate access for those who could benefit. The time for waiting is over, the time for action is now. ■

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Sam Mountney
Senior Policy & Campaigns Officer
Epilepsy Action
Tel: (+44) 0113 210 8889
smountney@epilepsy.org.uk
www.epilepsy.org.uk
www.twitter.com/epilepsyaction

So, you want to start a CBD brand?

Liam McGreevy and Elliott Findon from Ethnopharm Ltd highlight the key factors businesses must consider in order to set up a successful CBD brand, including; regulatory guidance, compliant product sourcing and labelling requirements

The cannabidiol (CBD) industry is one of the fastest-growing markets in the world and is expected to be worth £2 billion by 2025. Two recent surveys estimated that 4-6 million people have tried CBD in the UK alone, and you can now find CBD in major retail stores and advertised on television.

After years of being a niche product, CBD has now hit the mainstream and many entrepreneurs and established brands see the opportunity to capitalise on the growth. While it may seem relatively simple at first, there is a lot to consider when taking your first steps in entering this new market.

"Ethnopharm is a key resource for the cannabis industry, their experienced consultants can assist you with regulatory guidance, compliant product sourcing, labelling requirements, branding and marketing, and distribution channels."

Know the laws and regulations

Having a deep understanding of the laws and regulations surrounding CBD and other cannabinoids is crucial before you begin sourcing products and building your brand. Failing to do so could lead to hefty fines, criminal convictions or even jail.

CBD is legal across the majority of European Union (EU) member states but businesses should always research to ensure your products comply with the law in your jurisdiction, and companies such as Ethnopharm can assist you in ensuring you are complying with your local regulations.

Setting up your business

It is crucial to have all the correct legal documents in place at the start of the business to avoid banana skins down the track. Whether you are in business on your own, or in partnership with other people, good Shareholders Articles of Association are crucial to setting the right structure for the running of the business. Who is doing what, how are decisions made and when, and what happens when the business needs funding or a change of direction? If you manage to successfully grow your business and look to bring in other partners or investors, or to sell the business, having a good administration structure is extremely important.

Get a bank account

Every business needs a bank account and CBD businesses are no different, but unfortunately at the moment the banking industry is still wary and making it difficult for CBD companies to open bank accounts.

Although CBD is legal across most of the world the banking institutions still see these products as being high risk with potential links to money laundering, which is far from the truth for CBD retailers, but it takes time to break these barriers down.

There are some banks that are supportive, and companies are also known to register their business under a non-CBD associated name and trade under the CBD brand.

Branding

Building a brand's image can determine its product lines and offerings. Carry out market research to determine your target audience and create a brand identity and image that your customers engage with. Markets you may want to focus on are health and wellness, sports and fitness and beauty and cosmetics. In a competitive market customers buy into brand ethics so be sure to tell a story and stick to your values.

Find compliant suppliers

Hundreds of companies out there will supply you with bulk ingredients

or finished products, white label, private label or bulk CBD opportunities. Each has their advantages and disadvantages.

Branded CBD products:

Most CBD brands are looking for resellers of their products to build their brand presence and drive more sales. This can be a great way of entering the CBD industry with minimum investment.

Pros: Low minimum order quantities.

Cons: Limited control and smaller profit margins.

White label

White label CBD products are formulated and manufactured by an original supplier and then rebranded and packaged by other companies. This is a very popular option for start-up businesses and it is estimated that 90% of CBD brands in Europe are produced under white label. Before choosing white label it is important to consider how transparent your supplier is. Many can provide 3rd party lab reports and certificates of analysis but can they provide information on the whole process from cultivation to manufacture?

Pros: Unlike reselling existing brands white label allows you to build your own brand. Meaning you have complete control of branding your business. White label suppliers usually have low minimum order quantities meaning you can build a CBD range quickly with minimum expense.

Cons: Although white label gives you the opportunity to build a brand, the ingredients and formulation within your products can be sold by the white label manufacturer to other brands. This means although your brand is unique your product almost certainly won't be this can make it hard to stand out in a saturated market.

Private label

Similar to white label, private label is where a manufacturer formulates a custom product on your behalf. This means you get a unique custom-built product branded to your requirements.

Pros: Unlike White label, private label gives you more control over your finished product.

Cons: Private label is more expensive, often with higher minimum order quantities.

Labelling requirements

After choosing a reputable supplier and products it is now time to turn your focus to labelling requirements for your CBD products. The legal requirements can be complex, whether your product is food, cosmetic or vape, the safety of the ingredients is paramount within the EU, and if your product is not labelled correctly this can result in significant fines and reparation work, particularly with major high street retail chains.

Marketing

Marketing your CBD brand can be tricky, usual forms of paid digital advertising such as Facebook and Google are off-limits for CBD companies as both Facebook and Google restrict cannabis product advertising on their platforms. This means CBD marketers need to get creative to push their brands. Facebook, Instagram, and Twitter are great places to reach your target audience through organic likes, post regular updates and product testimonials to your social media pages to boost engagement. Making use of influencers is a very effective way to spread the message of your brand.

Sales & distribution

Once you covered off the company, product, labelling and branding, you need to start generating revenue! Sales channels are the same for CBD products as any other, D2C ecommerce or B2B into retailers.

If you have carried out some initial market research, you should have an indication of where the majority of the value is. For a small company without big retail connections D2C is a good way to get early revenue and brand traction while you work your way into the retail channels. Payment merchants can be an issue, for which Ethnopharm has a ready-made solution.

Major retailers bring huge consumer footfall but require significant marketing budget to increase the awareness of those consumers and convert them to buyers while in store, therefore smaller specialist health food retailers are a good early avenue to generate consistent bulk orders.

Ethnopharm is a key resource for the cannabis industry, their experienced consultants can assist you with regulatory guidance, compliant product sourcing, labelling requirements, branding and marketing, and distribution channels.

ETHNOPHARM

Liam McGreevy
CEO
Ethnopharm Ltd
Tel: +44 (0)773 865 8223
liam@ethnopharmgroup.com
www.ethnopharmgroup.com

Cannabinoids in medicine Part 2: Pain

In the second of a series of five articles, Oxford Cannabinoid Technologies will discuss their expertise on the medicinal use of cannabis derivatives

Following the first article that discussed the treatment of cancer, this second piece will focus on the use of cannabinoids to treat pain. Cannabinoids are active molecules found within the cannabis plant and include CBD and THC, two of the most notable cannabinoids currently being studied.

In the U.S. alone, the number of individuals suffering from chronic pain is close to 100m,[1] with two thirds of patients feeling that current medication does not meet their needs.[2] More people suffer from chronic pain than cancer, heart disease and diabetes combined.[3] Patients use cannabis to treat multiple forms of pain, with cannabis shown to address neuropathic (burning or lancinating), mechanical (dullness or aching) and inflammatory (acute or sharp) pain components or sensations.

Cannabinoid receptors are expressed in the peripheral and central nervous systems, as well as on immune cells. Pre-clinical data, *in vivo* animal model studies and a small number of clinical trials in acute, neuropathic, chronic and cancer pain models suggest that CB1 and CB2 receptors play an important role in pain processing and that modulation of the endocannabinoid system can alleviate pain.[4]

However, clinical trials have also shown that a thorough understanding of the interplay of various cannabinoids (e.g. THC vs. CBD)[5] and their specificity for different pain conditions, is essential to develop targeted pain medications that can help sufferers.

A growing body of research suggests that cannabis' psychoactive ingredients may enhance the pain-killing effects of opiate drugs, allowing patients using cannabis to take lower doses of opiate medications. Research in JAMA Internal Medicine found that deaths associated with the use of opiate drugs fell in 13 states after medical cannabis laws were introduced.[6] Those states that permitted patients to consume medical cannabis saw a 24.8% drop in opiate-related overdoses over six years.

However, these findings have since been thrown into doubt following the publication of a recent paper which suggests that claims that the enactment of medical cannabis laws reduces opioid related deaths should be met with cynicism.[7] The paper goes on to state that the association between these two factors does not hold when a more extensive data set from 2017 is analysed.

As cannabis continues to develop a foothold in the pain management market, product improvement cycles are likely to accelerate when research into individual cannabinoids becomes sufficiently advanced to allow the development of more personalised medicine. Current therapeutic options for patients living with pain are limited and consist predominantly of opioids and anti-inflammatory drugs. Over the years, it has become clear that the continued use of opioids has reached a crisis point in western economies, with many patients now dependent on these drugs. This fact, together with the large number of patients who do not react to the pain medication currently available on the market, highlights the need to develop additional methods of safer pain medication.

In drafted guidelines surrounding cannabis-based medicinal products published by NICE, the importance of collecting robust evidence regarding the long-term safety and effectiveness of medical cannabis was highlighted in order to remove barriers surrounding its prescription.[18] Rigorous, high-quality investigations into the use of cannabinoids in the treatment of pain are urgently required, as advised by The British Pain Society[19], in order for government policies surrounding the use of medical cannabis in pain treatment to be reformed and this therefore remains as one of Oxford Cannabinoid Technologies' main areas of focus.

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Key studies completed to date include:		
Publication	**Year**	**Finding**
Wiener Klinische Wochenschrift[8]	2006	A majority of 30 patients with chronic pain associated the addition of nabilone, a synthetic derivative of THC, with a positive result seen when the magnitude of benefit versus risk was compared for the individuals.
Rheumatology[9]	2006	Compared Sativex, a cannabis-extract mouth spray, with placebo in a randomised double-blind parallel group study in 58 patients receiving over 5 weeks of treatment for pain caused by rheumatoid arthritis. The results showed that the nabiximols oromucosal spray (Sativex) was statistically superior in reducing morning pain on movement and at rest.
Neurology[10]	2007	The results of a randomised placebo-controlled trial showed that smoked cannabis was well tolerated, and effectively relieved chronic neuropathic pain induced by HIV-associated sensory neuropathy. The findings were comparable to oral drugs used for chronic neuropathic pain.
Headache Pain[11]	2012	Compared the efficacy of nabilone and ibuprofen in reducing pain and headache frequency in 30 adults with long-standing, intractable Medication Overuse Headache ("MOH"). After eight weeks of treatment with each, nabilone was found to be statistically significantly more effective than ibuprofen in reducing pain intensity on a visual analogue scale and the number of concurrent daily analgesic therapies.
Clinical Gastroenterology and Hepatology[12]	2013	A clinical study of 21 patients with Crohn's disease who did not respond to therapy with steroids, immunomodulators, or anti-tumour necrosis factor-alpha agents. The study showed that smoked cannabis was statistically superior to placebo for pain relief, but not in the induction of remission.
European Journal of Pain[13]	2014	A study of 303 patients with peripheral neuropathic pain (PNP) rated their pain on a PNP 0-10 numerical rating scale (NRS). The results showed a statistically significant difference favouring a THC/CBD spray over a placebo alongside their current analgesic therapy. Measures of sleep quality also demonstrated statistically significant treatment differences in favour of the THC/CBD spray.
Clinical and Experimental Rheumatology[14]	2018	Assessed the possible pain and functional amelioration associated with medical cannabis therapy for low back pain ("LBP") in fibromyalgia ("FM") patients. The study demonstrated an advantage of medical cannabis therapy in FM patients with LBP, as compared with standard analgesic therapy, with significantly greater improvement in all patient-reported outcomes.
Journal of Pain[15]	2018	Demonstrated that the activation of CB2 receptor by a selective CB2 agonist (synthetic cannabinoid) can attenuate the central sensitisation and pain behaviour induced by paclitaxel, a chemotherapy drug, in a rat model. The authors concluded that MDA7, a selective agonist for CB2 receptors, represents an innovative therapeutic approach for treatment of chemotherapy-induced neuropathy.
Lancet Neurology[16]	2018	Showed that nabiximols, a synthetic cannabinoid, had a positive effect on spasticity symptoms in patients with motor neurone disease. There was also significant improvement in patients' global impression of change and a significant reduction in pain in the nabiximols group, compared with the control group.
Pain[17]	2019	Found that in a rat model for neuropathic pain, repeated treatment with low-dose CBD induces analgesia predominantly through TRPV1 activation, reduces anxiety through 5-HT1A receptor activation and rescues impaired 5-HT neurotransmission in neuropathic pain conditions.

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OXFORD CANNABINOID TECHNOLOGIES

John Lucas
Chief Commercial Officer

Lottie Phillips
intern
Oxford Cannabinoid Technologies
Tel: +44 (0)1865 304 040
press@oxcantech.com
www.oxcantech.com
www.twitter.com/OxCanTech

Is there a difference between Sativa and Indica cannabis?

Cannabis patient, budtender and growers assistant, Caleb McMillan, ponders if there is a difference between Sativa and Indica cannabis

Technically, there is no difference between Sativa and Indica cannabis. Of course, among cannabis connoisseurs, it's hotly debated. Sativas are supposed to be the coffee-like energy boost to your body and mind, while there's a reason why Indicas are sometimes known as "in-da-couch." As in, don't expect to be going anywhere when you consume it.

If you're going to a concert or festival, take a Sativa joint. If you're off to bed and looking for a non-alcoholic "nightcap", smoke some Indica.

Before you light up, it's important to be aware of your province or territory's non-smoking rules because they apply to cannabis, too. In BC, for example, smoking is banned in all public spaces and workplaces, including within six metres of doors, windows and air intakes. Also, don't share a joint with anyone under the age of 19 and don't carry more than 30 grams on you at one time.

But as I said before, technically, there is no difference between Sativa and Indica.

What consumers are feeling may be the placebo effect. Just as there's no difference in the alcohol of vodka versus beer. But, perhaps with cannabis, science hasn't discovered exactly what is happening in the brain when one consumes. There are over 420 compounds in the plant, after all.

Tetrahydrocannabinol (also known as THC) is the most famous. It's the active ingredient getting you "stoned." There's no such thing as a "Sativa" or "Indica" type of THC.

Why distinguish between Sativa and Indica?

The answer is due to the plant's botany. Sativas are taller and stalkier. Indicas are bushier and loaded with resin. Consumers can also choose hybrids, cannabis strains that are a mixture of Sativa and Indica.

Of course, any experienced cannabis farmer would admit that nearly all cannabis available to consumers is a hybrid of both. "OG Kush" may be labelled as an Indica, while "Girl Scout Cookies" may be labelled Sativa, but a more accurate classification would be "Indica-dominant" or "Sativa-dominant." Ideally, percentages would indicate how far on either side of the Sativa-Indica spectrum the strain rests.

Cannabis consumers report more cerebral experiences with Sativa, whereas Indica sends a buzz across your body, giving you the classic cannabis stereotype of couch-lock. For farmers, it's more of a technical matter. But "Sativa" and "Indica" are not cannabis compounds.

THC is a cannabis compound. So is cannabidiol (CBD)

There is no psychological effect on the mind with CBD like there is with THC. You can smoke joint after joint of CBD-heavy strains and come away only slightly buzzed, if anything at all.

CBD isolates, which extracts the compound completely and isolates it, give you zero buzz. So why consume it? CBD consumers report lower levels of anxiety when consuming it daily like a vitamin. Others report a reduction in their inflammation. And scientific papers back this up, as any quick Google Scholar search will demonstrate.

Due to prohibition, cannabis growers bred plant genetics high in THC and low CBD. The two compounds work like a see-saw, the more CBD in a plant, the less THC. Likewise, for consumers, the higher the CBD in their strain, the less effective the THC high.

With the end of prohibition in Canada, as well as many U.S. states, cannabis farmers are now selecting plant genetics high in CBD and low in THC.

But, regardless of whether the plant is CBD or THC dominant, Sativa, Indica or hybrid dominant, cannabis will produce terpenes.

What are terpenes?

You may be familiar with the terpenes produced by pine trees. Terpenes are an aromatic organic hydrocarbon. This is where the smell and aroma of the tree originates. The resin of a pine tree is the sap and can be used in essential oils.

"Stinging nettle" is a plant, many would call it a weed, found in many parts of the world. The plant has small little crystals on its leaves. This is what makes it sting.

Cannabis also has tiny crystals on it. Except instead of stinging you, it sticks to your fingers. Cannabis is, after all, the "sticky-icky-icky" as per American rapper Snoop Dogg. The little crystals on the cannabis plant won't sting you, they will stick to you. This is where all the THC is found.

If your cannabis is lacking these "crystals" or, more accurately, terpenes, then you do not have a good bud. The more "caked" a cannabis plant is in these terpenes, the more potent it is, the higher the aroma it carries and for many connoisseurs, the tastier it is.

Shatter and other extractions

Extraction methods can turn cannabis plants into a glass-like substance. This process isolates the terpenes and flushes the plant of all its carcinogens. You then vaporise the extracted cannabis product.

Known as shatter, this is cannabis-derived to its terpene essence. The consumer is not only getting a potent hit with one toke but tasting aromas one can't replicate by burning the plant substance.

This latter method of consumption is popular among medicinal patients who require high dosages for pain management. But it is also regularly demonised in the media likely due to its high potency and lack of understanding among medical professionals. Certainly, heating your consumption device with a hand-held torch sends a different message than using matches or a Bic lighter.

Yet, shatter continues to be popular, especially among Canada's medical cannabis population. Although it remains to be seen how they'll manage under recreational legalisation.

All previous medical regulations have been absorbed into the new legal framework. For better or worse, medical cannabis in Canada has become an afterthought for cannabis producers and lawmakers.

Instead of crafting regulations geared towards medical patients, the government has interpreted their court-mandated duty to "provide reasonable access" as completed under recreational legalisation. With plenty of stores and producers to buy from, medical patients are instead given the choice of writing off their cannabis purchases as medical expenses. They also have more leeway when it comes to public consumption and operating heavy machinery. But this varies, province to province.

Treating cannabis as a gift

It's hard to say why one plant works for so many different people for a variety of reasons. Perhaps we share an evolutionary history with the plant. Perhaps a higher power put it here for us to consume. Perhaps it's just a coincidence, a sort-of "it is what it is" situation. What's the saying? Don't look a gift horse in the mouth? Perhaps this is how we should approach the topic. ■

Caleb McMillian
Staff Writer
Cannabis Life Network
info@cannabislifenetwork.com
https://cannabislifenetwork.com
www.twitter.com/CannaLifeNet
www.minds.com/cannalifenet
www.instagram.com/cannalifenet/

Industrial hemp: Part of the cannabis sativa family

Henri Sant-Cassia from CBD Virtue turns the spotlight onto industrial hemp, a part of the cannabis sativa family

Hemp is quietly becoming one of the key components in the exploding cannabis industry worldwide. Less hyped than CBD, medical cannabis and recreational marijuana, it is now having the spotlight turned on it due to the sheer volume of possible uses, its environmental benefits and the sheer scale of global production.

Industrial hemp is part of the cannabis sativa family. It has its own medical benefits and is used in a vast range of products, as well as being the base ingredient in many cannabinoid supplements. Like CBD it is non-psychoactive and will not produce a high.

From the traditional uses in rope, paper, clothing, construction materials and biofuel, it is now increasingly being turned into organic cosmetics, health foods and nutraceuticals. Hemp tinctures, creams, balms, lotions and tablets are now available alongside the traditional packets of seeds and ground hemp seed powders which have been used as remedies for centuries.

Hemp-based flour for baking, packaging, compost, even bedding is now being produced. Hemp fibres are said to be the strongest natural fibres in the plant world and a lot of things which have traditionally been made from cotton or petroleum derivatives can now be made from hemp.

Hemp is also useful to farmers as a rotation crop that prevents soil erosion, absorbs carbon dioxide and removes toxins from the land. It is hardy, easy to grow, isn't fussy about climate and has high yields. Compared to cotton or petroleum it has clear environmental benefits and uses fewer resources. It is being promoted as a viable green alternative across the globe.

Demand for hemp is surging globally. By 2026, it is estimated the global market will be worth $13 billion. The two major producers of hemp are China and Canada, with giant commercial farms and massive factories for processing plants and creating extracts.

Today, large-scale hemp production is spreading with the U.S. catching up fast and regions from Lesotho in Africa to Colombia in South America setting aside land for farming. A boom similar to the palm oil boom is underway, which has raised the spectre of overproduction and pricing slumps.

The rise in demand is typically attributed to these new types of health- focussed products and a global movement to find healthcare solutions which do not rely on pharmaceuticals. Hemp oils and supplements are growing in popularity.

"Industrial hemp is part of the cannabis sativa family. It has its own medical benefits and is used in a vast range of products, as well as being the base ingredient in many cannabinoid supplements. Like CBD it is non-psychoactive and will not produce a high."

Hemp seeds are a fantastic source of protein and amino acids, including arginine which has noted benefits for cardiovascular health. For vegans and vegetarians, hemp seeds are a popular way to supplement dietary protein levels. They are a good source of vitamins, including vitamin E, B vitamins, zinc, iron, potassium, phosphorus and folate, amongst others. They are also rich in the fatty acid Omega 3 and rich in fibre.

If hemp is consumed in sufficiently high concentrations it can act as an anti-inflammatory. Tests on animals have shown it can have a noticeable effect, but human trials have been inconclusive. In fact, we should be cautious about attributing too many direct health benefits

Henri Sant-Cassia

to hemp seeds or hemp oil. Results are dependent on the amount consumed.

For example, industrial hemp does contain some CBD, the cannabinoid which is making headlines everywhere for its numerous medicinal properties, but levels are typically very low. Equally, while arginine is helpful for heart health, it needs to be consumed in sufficient amounts, so a few hemp seeds won't do much. There are some claims and early clinical evidence that hemp could help treat atopic dermatitis (AD), acne and arthritis, but there are no conclusive scientific studies yet. For now, it remains a healthy dietary supplement with a lot of untapped potential for the future.

Industrial hemp is also used in the production of cannabinoids. Typically the plant has relatively small amounts of CBD and other cannabinoids like THC compared to other species of cannabis. However, by processing a lot of plant matter it is possible to produce concentrated extracts. Many experts believe this kind of harsh extraction can damage the cannabinoid molecules and purists prefer cannabinoids produced from special non-hemp varieties of cannabis sativa with higher cannabinoid levels which can be extracted gently.

There is also a danger that because hemp is such an efficient bio absorber – pulling out heavy metals and toxins from soil – that edible products made from hemp will be contaminated with poisonous substances it has absorbed while growing. Buyers need to check for proper safety and test certificates that show products are pesticide, heavy metal and toxin-free. ■

Henri Sant-Cassia
CBD Virtue
Tel: +44 (0)20 3092 3261
info@cbdvirtue.co.uk
www.cbdvirtue.co.uk
www.twitter.com/cbdvirtue

Celtic wind crops: Leading the way in the hemp industry for a sustainable future

Paul McCourt CEO and Founder of Celtic Wind Crops.EU, explains how his firm is leading the way in the hemp industry for a sustainable future

At Celtic Wind Crops, we created this tagline working towards a sustainable future as we truly believe that we are creating a sustainable business to lead the way in the hemp industry for the future.

The industrial hemp plant has many uses and Celtic Wind plans to capitalise on all of them, having no waste of any of the plant's parts, therefore, creating health food supplements, natural fibres for industries and wood core for building and bedding products.

We use no chemicals in any of these processes and if we have any waste it is returned to the field from which the crop came to replenish the nutrients and, therefore, completes a fully natural crop cycle.

The company's founders have been working with hemp since 2009 and registered the business in 2012 with a view in mind to bring the hemp industry to Ireland and be a globally traded business.

Creating jobs and making a difference to the economy and the environment, the 2019 crop of 500 acres will capture during its growth cycle over 1,650 tonnes of carbon from the atmosphere this season. This is equivalent to the carbon produced in over 220 American households every year.

We understand the plant and how it performs in different conditions and reintroducing old natural farming techniques to produce a unique range of natural products. We have also created our own supply chain; we call this seed to shelf which means we are in full control of all of our own raw materials and manage everything from putting the seed into the ground all the way through to the finished bottle on the shelf giving our customers total confidence in Celtic Wind.

> "Legislative guidelines require that because of its relationship to the cannabis plant, industrial hemp must be below 0.2% THC when tested in the field, however, regulations state that not one milligramme of THC or any other controlled substance may be found in the finished product."

By introducing these old farming techniques like meadow planting, this allows Celtic Wind to grow a natural crop without the use of agrichemicals, this leaves a boundary around the field so wildlife can come back to protect the crop, encouraging white butterflies, ladybugs and bumblebees that all play a role in maintaining a healthy crop by controlling disease and infestations naturally.

This is an industry that can no longer be overlooked with all the benefits it brings when you support the hemp industry by making a difference in the environment and the economy in which these businesses are located. It creates jobs, protects the environment and gives us clean natural raw materials to work with. As you would be creating these resources locally, it would cut down the impact on transportation of goods and mining for resources, reducing our global carbon footprint overall.

If we make the decision to switch 40% of the world's agricultural crop to hemp over the next five years, this would have a positive fundamental impact to local economies and environments, therefore, contributing to the global community.

However, industrial hemp is known to be one of the toughest agricultural crops in the world to deal with, standing over 12 feet tall with natural fibres that can be as strong as steel when they wrap around machine parts, cause real problems for modern machinery. To harvest and process this crop correctly, you need a lot of heavy-duty machinery and infrastructure and this is still certainly lacking in the UK and Ireland today. This is one area that has really held the whole industry back: support for infrastructure and clearer regulations as most countries tend to make their own legislative changes on industrial hemp. Legislative guidelines require that because of its relationship to the cannabis plant, industrial hemp must be below 0.2% THC when tested in the field, however, regulations state that not one milligramme of THC or any other controlled substance may be found in the finished product.

We are heavily regulated in this industry by government bodies such as the HPRA, FSAI, HSE and the Department of Agriculture and, of course, Celtic Wind products comply with all European Union (EU) and United States (U.S.) legislation.

Celtic Wind had to create their own infrastructure as there are limitations on harvesting hemp seed. We only have eight hours from when we start to harvest before the seed spoils and turns rancid, so this means Celtic Wind only harvest approximately 100 km from the facility to ensure we can protect and stabilise the crop within this time limit, so harvest to storage takes place within eight hours.

This also allows for full traceability, if you pick up a Celtic Wind product and read the little batch number on the side of the bottle back to the company, they can tell you the day that crop was sown, the date it was harvested and every station in the processing facility that it passed through on its way to the shelf.

Celtic Wind carries out all its processing and operations in Ireland and Northern Ireland, where day employ most of their staff, over 18 now and have started employing in the UK and the U.S.

At Celtic Wind, even though we work with an ancient crop, we embrace modern technology to help us make the most out of the hemp plant: you can see from our videos the drone photography of the beautiful local area we grow in, what you might not realise is that under that drone a whole bank of sensors take readings from the crop to inform and indicate certain areas of interest. Our monitoring system will predict yield, detect disease and provide solutions for this.

We are pushing the boundaries in agricultural science and biotechnologies with our crop monitoring system especially for hemp and new product development areas. This all combined gives Celtic Wind the ability to produce a wide range of products for different industries. We have just extended our ingestible range with three new capsule products called Synergy and have now launched pet care to the market, coming soon is the body care range, again all fully natural and traceable. Further applications of the raw materials will include eco-friendly building materials such as natural fibre insulation and structure-forming wood core products for the sustainable building industry.

We at Celtic Wind truly believe this is the way forward for business and industry alike, creating natural resources from a sustainable ancient crop like hemp an annual spring break crop that can feed, clothe and shelter if you know how to work with this amazing plant.

For further information please see www.Celticwindcrops.com

Celtic Wind Crops

Paul McCourt
CEO and Founder
Celtic Wind Crops.EU
Tel: +353 (0)1 678 0804
info@celticwindcrops.eu
www.celticwindcrops.com

Cannabinoid products: Create the best organic hemp products for the mass market

A worldwide manufacturer and distributor of cannabinoid products, Elixinol are committed to creating the best organic hemp products for the mass market

Elixinol was founded by a group of passionate leaders led by British born Paul Benhaim. Committed to becoming a leading worldwide manufacturer and distributor of cannabinoid products. They have over 20 years of relationships with hemp farmers around the globe.

Benhaim learned in 1991 that hemp seed is a superior source of essential fatty acids, and has been working with it ever since. Since his first product, the '9bar' snack bar (one of the world's best-selling hemp products), he has developed numerous businesses, and supported government policies and global strategies to grow and develop the industrial hemp industry.

His obsession is to create the best organic hemp products for the mass market. Paul works with seed breeders and suppliers, growers, harvesters, cleaners, primary processors, manufacturers, laboratories and quality control personnel (in-house, contracted and third party) to source the highest-quality hemp from around the world for use in Elixinol products.

After learning about hemp seeds in 1991, Paul Benhaim immediately began tracking down the best hemp in the world. He has worked in England, Germany, France, Spain, Italy, Slovenia, Czech Republic, Lithuania, Poland, Hungary, Korea, Thailand, India, China, Canada, U.S., Australia, New Zealand and more!

Paul has travelled the world for the last two decades, making close friends and colleagues in his chosen speciality – the highest-quality hemp on the planet!

Elixinol has hemp farms in both the U.S. and Europe; hemp extracts from Elixinol U.S. are grown in Colorado, while Elixinol Europe's hemp comes from farmers in Europe. They work from seed to sale with farmers and producers in each location to ensure they formulate the very best products for you.

Before they ship from their manufacturing facility, all the products undergo rigorous testing. Then they use advanced HPLC (HPLC-DAD) equipment, in leading labs, to confirm the results. Besides testing for potency, they also test for microbiological contamination, heavy metals, pesticides and the unique terpene profile.

To establish the best labs for testing their products, they initially submit multiple samples of the same product, as well as "dummy" samples, to assure stability of the lab's analysis methods and their ability to identify abnormalities in our products. This also allows them to be sure that they report any abnormalities immediately. Good communication and attention to detail are critical to the Elixinol process.

They employ these quality-control measures in every batch of Elixinol product they manufacture. There is never a question of what an individual is receiving when they make a purchase.

They use only hemp-based product testing laboratories that mirror pharmaceutical-industry processes and controls. Through these processes, they've solved the common problem of inconsistent test results. The testing team comes from the pharmaceutical industry, understands the complexity of operating in a cGMP/GLP environment and has operated in this environment for decades.

Elixinol gives customers and partners greater peace of mind by providing batch and lot numbers for each product. They identify each batch of a product that is manufactured (GMP). This is essential in ensuring consistent quality. They provide full transparency to their customers about what they are buying at any given point in time.

It also assures that should an issue arise; they can rapidly perform a recall on that specific batch and know exactly who may be in possession of a product derived from that batch. Lastly, it allows them to communicate clearly with their manufacturing partners so that they can identify any issues that may arise on the manufacturing side of our business.

They publish certificates of analysis

Paul Benhaim

> "Before they ship from their manufacturing facility, all the products undergo rigorous testing. Then they use advanced HPLC (HPLC-DAD) equipment, in leading labs, to confirm the results. Besides testing for potency, they also test for microbiological contamination, heavy metals, pesticides and the unique terpene profile."

for all of their products. They work closely with a team of medical professionals to conduct intensive research and development of formulations. Elixinol is proud to lead the industry when it comes to safety, product innovation and value for money. They are experts with decades of experience working with truly natural products. They know how to extract, process and formulate the ingredients they carefully select, without resorting to synthetic chemicals. They maintain a strict policy of no GMO products whatsoever.

Their own in-house formulator develops and oversees the innovative methods we employ to make our products safe and enjoyable to use. They also continue to invest in manufacturing facilities to expand the range of products they can make, without ever compromising on values.

These same values are applied when choosing ingredients for flavouring their edible products or developing non-toxic skin products. The Cinnamint tincture, for example, uses a variety of cinnamon that is extracted using the same solvent-free Super Critical Fluid Extraction techniques used to extract their hemp plants. The result is record levels of cinnamaldehyde, a compound that offers more than just great natural flavour.

Elixinol Global Limited is an ASX listed company with a global presence in the cannabis industry through its subsidiary businesses.

Nunyara an emerging Australian medicinal cannabis company who recently had a Manufacturing License granted and are looking forward to shortly receiving a Medicinal Cannabis License the Australian Office of Drug Control.

Hemp Foods Australia is a leading hemp food and skincare products wholesaler, retailer, manufacturer and exporter of bulk and branded raw materials and finished products.

The Certified *Organic Sativa skincare range contains wholesome hemp oils and extracts. Fortified with Synergistic Botanicals from the Amazon and wild Australian outback, Sativa satisfies the health and beauty needs of your skin.

Most recently Elixinol purchased 25% of Pet Releaf, a world leader in the development of CBD products for Pets. The Elixinol mission is to transform health, through cannabis plant science and technology.

Elixinol
www.elixinol.eu
www.twitter.com/ElixinolCBD
Instagram: elixinol_eu
Linkedin: elixinol-europe

Organic hemp producer BioBloom: “Health is our main focus”

BioBloom has specialised in the production of high-quality organic hemp products with absolutely no additives since 2016. The production focuses on the preservation of all valuable ingredients of the hemp plant

When BioBloom started with their first hemp test fields in northern Burgenland (Austria), it became immediately clear that the company would focus on people’s health and well-being as well as the careful use of nature’s valuable resources. Four years later, this vision still drives the BioBloom mission and is implemented by the three CEOs Elisabeth Denk, Christoph Werdenich and Thomas Denk, together with a team of 15 employees.

The BioBloom hemp CBD extracts are 100% natural and organic hemp full extracts and contain the full spectrum of the hemp plant with absolutely no additives.

BioBloom is now one of the most established hemp producers in Austria and Europe. The raw material, especially the hemp flowers, comes exclusively from the hemp plants from their own certified organic fields consisting of approximately 110 hectares. A specially developed cultivation technique guarantees the hemp plants have enough space and light and that they grow healthy and strong. In addition, nutrient-rich soils and the mild Pannonian climate ensure that the hemp plants develop high concentrations of the hundreds of valuable hemp ingredients such as CBD (cannabidiol). The hemp plants are harvested carefully and the hemp flowers are processed exclusively by hand before going through a particularly gentle CO_2 extraction process in the certified laboratory NateCo2 in Germany, all of which guarantee the highest quality CBD hemp extracts containing the full spectrum of the hemp plant and absolutely no additives.

Collaboration with well-known scientists and doctors

BioBloom combines three decades of experience in organic agriculture and the millennia-old knowledge of the hemp plant, which is one of the oldest cultivated plants in the world, to create innovative natural products of the highest quality. The company and all of its products are BIO AUSTRIA certified, and the production is also supervised by scientific, pharmaceutical and medical experts. One of the external scientific consultants is Gerhard Nahler, M.D., Ph.D., and CEO of CIS GmbH in Vienna, Austria.

Gerhard Nahler is well known from publications on various aspects of cannabinoids and cannabis. Among other institutions such as ICANNA, he has also collaborated as an independent expert with the European International Hemp Association (EIHA) on the area of hemp extracts and hemp food aspects. “From the past, I know the production of high-quality products”, says Gerhard Nahler concerning his collaboration with BioBloom.

Quality, transparency and the preservation of all the valuable ingredients of the hemp plant are the focus of every production step at BioBloom. Trained employees harvest the hemp plants mostly by hand and the hemp flowers are then processed exclusively by hand. This ensures the CBD and the approximately 500 other valuable ingredients of the hemp plant are preserved as best as possible.

BioBloom draws upon findings from cannabis research in its production, especially the entourage effect. This states that the ingredients of the hemp plant have the best bioavailability in combination with each other and not as isolated pure substances. That is why the main focus in every step of the production process, from the

The three CEOs Christoph Werdenich, Elisabeth Denk and Thomas Denk in the certified organic BioBloom hemp fields

careful harvesting to the processing by hand all the way to the certified CO_2 extraction, is the preservation of the cannabinoids, terpenes, flavonoids and all the other valuable ingredients. BioBloom absolutely refuses to use any additives and enrichment with CBD isolates.

Certified and quality-tested CBD full extracts

The 100% organic and natural CBD hemp extracts from BioBloom are available in natural CBD/CBDA concentrations of 4%, 6% and 8%. CBDA (cannabidiolic acid) is the acid precursor of CBD and increases its bioavailability. In addition, other valuable properties are also attributed to CBDA. In 2018, it was possible for the first time to produce a 100% natural hemp extract from CO_2 extraction with 10% CBD/CBDA. The plants on a test field had developed extremely well.

Many physicians and pharmacists in Austria and Europe already rely on the pure natural hemp extracts from BioBloom and use them in the treatment of their patients. Including the gynecologist Dr. Iris Pleyer, who published a book on cannabidiol in 2019. "I follow a holistic approach in my work as a physician and have been working with cannabidiol (CBD) since the end of 2013. Natural full extracts with the full spectrum of the hemp plant simply work best. BioBloom, with its certified organic and pure natural hemp full extracts, is clearly one of the suppliers I trust. Quality is very important to me as a doctor!" says the author and physician Dr. Pleyer about BioBloom hemp full extracts.

The BioBloom certified organic hemp extracts are also available in pharmacies and selected shops in many European countries. In a comparison test of 46 European CBD products by the independent patient association ARGE CANNA (www.arge-canna.at), the BioBloom products were among the test winners and in recognition of their quality the patient association also awarded them the AC seal of quality.

Innovative product development

The product range also includes the unique hemp flower tea with hemp flowers from the BioBloom fields picked and processed exclusively by hand. The main component of the organic hemp flower tea is the water-soluble CBDA, which makes the tea especially helpful for people who have trouble sleeping. In addition, the BioBloom brand also includes hemp food products such as organic hemp oil from peeled hemp seeds and hemp seeds, peeled & ready to eat.

The certified organic hemp cosmetic series "Into the Wild" is the latest addition to the product range from BioBloom. The organic cosmetic series includes a body lotion, face cream, hand cream and an SOS balm. The product was developed following the company philosophy focusing on improving people's health and well-being as well as the careful handling of nature's valuable resources. The cosmetic products are certified organic, vegan, cruelty and palm oil free, allergen free and GMP certified.

BioBloom is also working intensively on new innovative hemp plant products as well as the internationalisation of its brand (Japan, Canada, etc.). The product developments include other health-promoting products from hemp, as well as other plants and their ingredients that BioBloom intends to use for new products in the near future. All this, while always staying true to the vision that has been at the heart of BioBloom as a BIO AUSTRIA quality partner since it was founded.

"We are convinced that the many valuable ingredients of hemp plant only develop their full potential in synergy with each other. Our goal is to help people stay healthy and active and find inner balance with our pure natural products," say the three CEOs with conviction.

BioBloom. Hemp

Katharina Zedlacher
PR and communications
BioBloom GmbH
Tel: +43 680 301 1415
katharina@biobloom.at
www.biobloom.com

Why Europe needs to end coercion in mental health

Claudia Marinetti, Director of Mental Health Europe tells us why Europe needs to end coercion in mental health

Mental health affects us all, in every aspect of our lives. It influences our relationships, how we work, where we live, and even our basic human rights. Positive mental health today is gaining a greater spotlight. It becomes a more high-profile issue for both policymakers, employers and the general public. Despite this, Europe remains dependent on outdated practices in mental health care. Institutionalisation, excessive medicalisation and coercion[1] are still used against people with mental health problems throughout Europe, from West to East.

Recent figures show the growing use of involuntary measures in mental health in the UK, Belgium, France and the Netherlands. In England, for example, the rate of involuntary psychiatric hospital admission has increased by more than a third in the past six years.

Informed consent to medical treatment is at the centre of good quality healthcare. Non-consensual practices challenge this presumption. Involuntary "treatments" such as forced medication or forced electroshock can be particularly traumatic when administered against people's will. They also raise ethical issues due to the evidence of potentially irreversible health damage. Coercion is often the reason why people with mental-ill health avoid or delay contact with the healthcare system. Fear of losing their dignity and autonomy results in further negative health outcomes. Life-threatening distress and crises situations lead to even more coercion, and the vicious cycle repeats.

The notion of risk of self-harm or harm to others has been a justification for involuntary measures in many European countries. However, there is no empirical evidence that coercion helps people who are potentially dangerous to themselves or others. There is no association between mental health conditions and violence neither. Instead, personal testimonies collected in Mental Health Europe's Mapping Exclusion report document overwhelmingly negative experiences of involuntary placement and treatment: trauma, fear and pain from the use of physical restraint, involuntary hospitalisation, pressure to sign consent forms for admission or treatment, absence of information and social isolation to name a few.

Coercion paves the way for massive and systemic violations of human rights. This includes the right to healthcare based on free and informed consent and the right to active and informed participation in decisions – one of the core human rights principles. If we want people with mental ill-health to fully enjoy their human rights and participate in society, their involuntary, forced and non-consensual treatment must end.

So how can Europe abandon unacceptable and outdated coercive practices? And what's needed to achieve the transition towards alternatives that respect human rights?

Mental health systems across Europe should be reformed to adopt a human rights-based approach, which is compatible with the United Nations Convention on the Rights of Persons with Disabilities (UN CRPD) and respectful of medical ethics. The UN CRPD, ratified by all the European Union (EU) Member States and the EU itself, calls for a paradigm shift: mental health services should be centred around people and their recovery.

Many countries across Europe have already started the reform; there are moves at the international level too. Several United Nations bodies have called to reduce, end and prevent coercion in mental health settings. The recent resolution of the Council of Europe (CoE) to end coercion in mental health is another positive sign.

Claudia Marinetti, Director of Mental Health Europe

It shows a commitment to human rights in mental healthcare from one of the most prominent international human rights organisations in the European region. What particularly encourages us is the CoE Parliamentary Assembly (PACE) recommendation to the Member States to start the abolition of coercive practices.

As part of the same debate, in June 2019, PACE also recommended the Council's Committee on Bioethics (DH-BIO) to shift efforts away from working on an Additional Protocol to the Convention on Human Rights and Biomedicine, also known as the Oviedo Convention. The Protocol regulates 'involuntary placement and treatment of persons with mental disorders.' Mental Health Europe and other European organisations representing people with lived experience, along with United Nations experts and internal bodies of the Council, have strongly opposed the DH-BIO's work on the Additional Protocol and urged to withdraw the draft. The Additional Protocol is considered to be out of step with the UNCRPD. It solidifies rather than reduces institutionalisation and forced treatment of persons with psychosocial disabilities. There is nothing but hope that the ongoing negotiations on the Additional Protocol to the Oviedo Convention will stop after PACE's rallying call. PACE encourages DH-BIO to focus on promoting voluntary measures instead. Drafting Guidelines on ending coercion in mental health, for example, could help States better implement their legal obligations regarding the rights of people with disabilities.

Holistic mental health systems are crucial to truly eliminating coercion. It is not about changing individual practices but about implementing a new culture. Mental health services in the community should reflect international standards that protect human rights and dignity of persons with psychosocial disabilities. Their provision must have a positive impact on people's health and recovery. Only the elimination of coercion can ensure this systemic change. A combination of both grass-root work and overarching strategies seems the best way forward to end coercion in practice. ■

1 Coercion or coercive measures refer to involuntary, forced or non-consensual practices used in mental health services against people with mental health problems.

Claudia Marinetti
Director
Mental Health Europe
Tel: +32 2 227 27 08
info@mhe-sme.org
www.mhe-sme.org
www.twitter.com/MHESME

Sleep is the best medicine: The repair programme that strengthens resilience

In this article, Dr Hans-Günter Weeß explains the connection between sleep, mental health and strengthening resilience

What does sleep have to do with mental health and resilience? How does the "most important third" of our life affect not only the immune system of our body but also that of our mind and soul?

Dr Hans-Günter Weeß has a degree in psychology and in Germany he is an absolute expert in sleep research. He is the head of the interdisciplinary sleep centre at Pfalzklinikum, Klingenmünster.

"People with chronic sleep disorders have more than double the risk of developing depressions than people with a healthy sleep. The probability of developing anxiety disorders and addictions is also higher."

Sleep is a highly active process. Sleeping people consume only slightly less energy than people who are awake. Recent sleep research clearly shows that sleep is a human being's most important regeneration and repair programme. Nevertheless, more than 80% of the Germans use an alarm to get up in the morning and terminate their most important regeneration programme prematurely before it has fulfilled all its tasks. Human beings are the only beings on our planet who shorten sleep artificially and do not sleep in.

Sleep supports regeneration and learning processes

Sleep has irreplaceable functions for the human body and a well-balanced psyche: for instance, it strengthens the immune system.

Several studies have shown that in cases of enough healthy sleep, natural defence cells are built in a larger quantity and it is easier to fight bacteria and viruses. One night without sleep, for example, already leads to a reduction of the function of T-cells (T-lymphocytes or for short T-cells form a group of white blood cells helping the immune defence), which search infected cells and kill them. In some studies, human beings were given cold viruses and a connection between the duration of sleep and the onset of a cold was revealed. Shorter sleep was associated with an increased probability of catching a cold.

During deep sleep the hypophysis releases growth hormone. It has growth and metabolism-enhancing effects. Growth hormone mainly works by activating growth factors on muscles, liver, bones and on the cells of the fatty tissue. It is responsible for energy storage processes at the cellular level and, thus, a key element of physical and mental regeneration.

Sleep is also a decisive factor for the formation of the memory. During

sleep the information newly acquired over the day is transferred from the short-term and working memory into the long-term memory and unnecessary information is rejected. For this reason, sleep experts advise us to take a regular afternoon nap of 10 up to a maximum of 20 minutes, especially for active learners but basically to ensure a healthy and long life. Studies demonstrate that a short nap between learning phases helps memorize factual information more easily.

Sleep is important for the mental well-being

Sleep does not only help people who are learning, but also regulates emotions. The advice to "sleep on it for a night" is legitimate, as even in case of difficult emotional situations information that is less important for the cause is filtered out of the memory during sleep. The next morning, we can simply think and judge more clearly. A lack of sleep, however, makes you more reckless and more willing to take risks and leads to more errors in case of complex decision processes. That puts a completely different perspective on certain decisions made in politics and business after long night sessions.

People with chronic sleep disorders have more than double the risk of developing depressions than people with a healthy sleep. The probability of developing anxiety disorders and addictions is also higher.

The importance of a healthy sleep is already revealed in early childhood and adolescence. Children and teens who sleep well and sufficiently are more stable regarding their ability to regulate emotions and more balanced when dealing with other people. In turn, young people who sleep badly all the time tend to show rather dissocial, excited and impulsive behaviour and an impeded social development. Each hour of sleep deprivation heightens the risk of leading an unhealthy lifestyle with insufficient physical activity and weight gain, as well as increased consumption of fast food, nicotine and caffeine. Even with one hour of sleep less than preset by our genes the probability of overweight increases by 23%.

Sleep protects against age-related diseases

During sleep, waste products generated by neurons in the brain over the day, so-called amyloid plaques, are degraded again so that the human brain maintains its functionality. For this reason, enough sleep enables people to grow old successfully while enjoying good health and reduces the risk of age-related diseases, such as dementia and Parkinson's disease.

Sleep makes us alert and productive. Often, we only realise how important it is when we do not get enough sleep. Depending on the study, up to 43% of the Germans feel "quite often", "mostly" or "always tired" during the day and not well rested (DAK health report 2017). The consequences of sleep deprivation on the psychosocial level of performance, however, are not always apparent, but they can have disastrous consequences because sleep deprivation, like alcohol, slows down the reaction time. Lethal traffic accidents on German roads are twice as often a result of lack of sleep than of alcohol consumption.

> "Recent sleep research clearly shows that sleep is a human being's most important regeneration and repair programme."

Consequently, whoever sleeps sufficiently and well is not only physically and mentally fit but also has a better mental balance and resilience. Vice versa physical and mental well-being results in a more relaxing sleep. It constitutes a cycle that provides many reasons to attach more importance to sleep and to sleep soundly again.

Dr Hans-Günter Weeß
Psychologist and Head of Interdisciplinary Sleep Center
Pfalzklinikum
hans-guenter.weeß@pfalzklinikum.de
www.pfalzklinikum.de

Recovery from stroke: The challenges

Juliet Bouverie, Chief Executive of the Stroke Association explores the challenges around recovery from stroke

When stroke strikes, part of your brain shuts down. The impact is devastating. It could be anything from wiping out speech and physical abilities to affecting a person's emotions and personality. There's no doubt that recovery from these effects takes time, a ton of courage, determination and support.

Doctors, physiotherapists and speech therapists are a vital step in helping stroke survivors rebuild their lives, but we need to know what struggles stroke survivors face that advances in medical knowledge cannot solve. This is why the Stroke Association commissioned our largest ever survey of UK stroke survivors to form our four-part Lived Experience of Stroke report.

Throughout 2018, over 11,000 stroke survivors and carers from across the UK told us about their experience of stroke. They shared their thoughts and feelings about the severity of their stroke, life after their stroke, the things they have found challenging to adapt to, the support they have received, and the areas in which they wish they had been better supported.

Every day, my colleagues and I at the Stroke Association hear upsetting stories which bring the research findings to life. We hear of marriages broken and suicide attempts, of jobs lost, houses sold and stroke survivors, their families and family carers becoming homeless. When I first joined the Stroke Association, I was told about one man who lamented that living with the effects of stroke wasn't a life worth living for him and that he'd rather have died in hospital. On the most basic level, this is upsetting and speaks of the psychological trauma a stroke can cause. We now have robust data to show what we knew anecdotally, that the stroke population desperately needs emotional and psychological support.

For too long now, the social and psychological impacts of stroke have gone unnoticed and have been overshadowed by the importance of physical rehabilitation. There are currently 1.2 million stroke survivors in the UK. Alarmingly, we found that nearly a million stroke survivors have a mental health problem as a consequence of their stroke. Three-quarters of survivors face a battle with depression, anxiety, lack of confidence, mood swings and even suicidal thoughts. Devastatingly, a quarter of these people say they haven't had the emotional support they should be getting, and so desperately need, to rebuild their lives.

Overall, nine out of ten survivors experience at least one cognitive effect including fatigue, problems with concentration, decision-making, reading, writing and poor memory. These challenges are compounded by the worry that another stroke may be on the way.

A stroke at any age can be devastating, but the condition is particularly cruel when it hits people of working-age. One in every four strokes happens to a person aged 18-65. We now know that nearly half (43%) of working-age stroke survivors are faced with financial hardship after their stroke and over half (51%) gave up work or reduced their working hours following their stroke. Nearly one in six (15%) working-age stroke survivors experienced discrimination, missed out on a promotion or said their employer was not supportive.

Of course, the psychological and physical effects of stroke can be heavily intertwined, as often the mental and therefore hidden impacts of a stroke affect a stroke survivor's ability to work as much as the physical impacts. Employers often do not understand the breadth of consequences that a stroke can have on a person; this is symptomatic of the public's overall lack of stroke knowledge. For example, 14 million people who know a stroke survivor don't even realise that stroke happens in the brain.

Juliet Bouverie, Chief Executive of the Stroke Association

Our stroke recovery teams provide stroke survivors and their families with information and advice on how to rebuild their lives after stroke, including signposting to other services and support with filling in disability benefit application forms. The Stroke Association's service teams help stroke survivors get back to work and provide advice to reduce the financial burden that a stroke can have on a survivor. We have developed My Stroke Guide to help stroke survivors access vital information and offer peer support online and we also run the Stroke Helpline as further support for everyone affected by stroke.

The evidence highlights how important it is that families, friends and health professionals who support stroke survivors understand what it means to live with these 'hidden effects', ask how people are feeling and provide appropriate social, emotional and psychological support. We have pushed for psychological support to become a higher priority and I'm pleased to see more holistic support included in the National Stroke Programme. The programme aims to deliver on stroke goals in the Long Term Plan and we are proud to be working closely with NHS England to develop and deliver it. Please do refer your clients who may be affected by stroke to the Stroke Association's vital information and support services (see below for details). We're here to help rebuild lives after stroke. ■

Useful resources

Stroke Helpline +44 (0)303 303 3100

My Stroke Guide.

Stroke and Benefits.

Stroke and Work:

https://www.stroke.org.uk/sites/default/files/user_profile/complete_guide_work_and_stroke.pdf

https://www.stroke.org.uk/life-after-stroke/getting-back-work

Juliet Bouverie
Chief Executive
Stroke Association
Tel: +44 (0)300 3300 740
supportercare@stroke.org.uk
www.stroke.org.uk
www.twitter.com/TheStrokeAssoc

Mirror Hand: Maximising neuroplasticity through robot-assisted rehabilitation

Here, Jen-Yuan (James) Chang discusses pioneering research and innovation by National Tsing Hua University of robot assisted rehabilitation for those who have suffered a stroke

To contend with an aging population and limited availability of healthcare manpower, the adaptation of robotics in rehabilitation has increased. In particular, developed countries are where aging is having a significant effect in result in long-term disabilities. Stroke, which can primarily contribute to hypotonia and chronic hemiparesis, have been found to be one of the major causes for long-term disabilities, leading to limb/hand functional impairments in patients. Due to limitation of muscle motor capabilities, hyperexcitability of the stretch reflex is commonly found in stroke patients. The so-called "stiffness" or "tightness" of muscles in the stroke patients is referred to the muscle spasticity which is caused by hyperexcitability of motoneurons. In medical practices, it is found that with precise and repeated range of motion (ROM) exercises, the aforementioned flexor hyperexcitability can be reduced. In present practices, the ROM exercises are operated by therapist's hands to temporarily reduce the severity of spasticity. In evidence-based medicine, it is demonstrated that with robot-assisted rehabilitation, the high-repetitive and high-precision movements can greatly improve the quality of rehabilitation for stroke patients.

In this article, an exoskeletal robot which is designed to perform precise and repeated robot-assisted movements by aligning with human finger counterparts is discussed in the context of a commercially available product called "Mirror Hand" by Rehabotics Medical Technology Corporation (RMTC). The technology behind this Mirror Hand robot was developed by Professor Chang's group in National Tsing Hua University and Dr Yu-Cheng Pei's group in Chang Gung Memorial Hospital, Taiwan through a project named "Development of Customized Robot-Assistive Exoskeleton System for Palm-Finger Physical Rehabilitation" which was funded by Ministry of Science and Technology, Taiwan and later transferred to the RMTC.

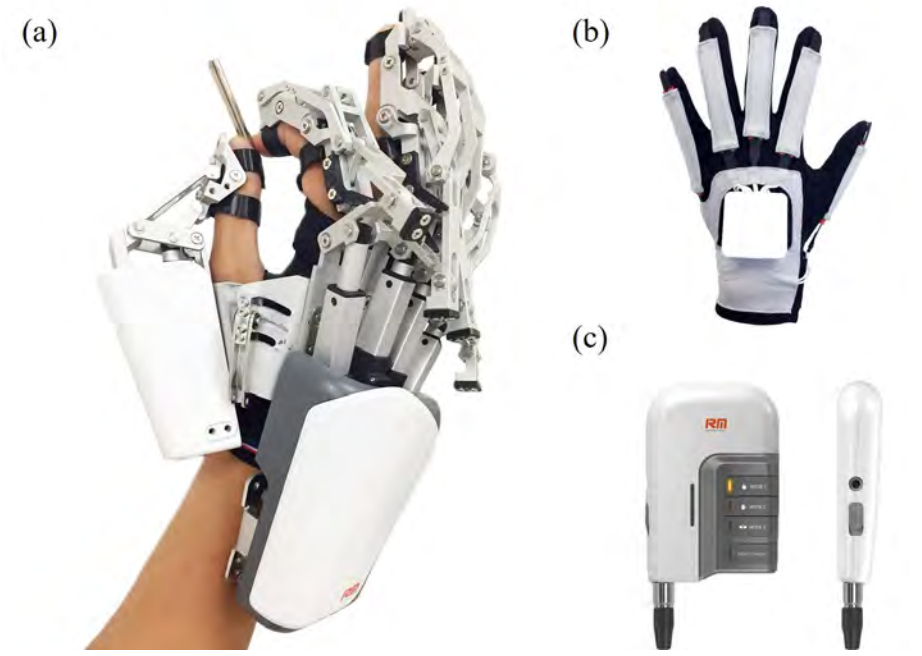

Figure 1. (a) The exoskeletal hand of the Mirror Hand robotic device that offers dexterity for impaired hand, mimicking healthy hand's movement acquired by (b) the sensor glove processed by the (c) portable control box.

Traditionally, the rehabilitation process is conducted in hospital or clinics due primary to the device's inevitable bulky mechanism, not to mention the possibility of offering dexterous movement in stroke patient's fingers. To offer enough dexterity and work with the traditional rehabilitation used in everyday situations, the Mirror Hand as illustrated in Figure 1 is designed to be a light-weighted, convenient to use, and easy-to-operate hand robotic device that can be used both in traditional rehabilitation units in hospital/clinics and in-home care with supervision of medical personnel. Accounting for human factors and natural movement of fingers, the exoskeletal hand as shown in Figure 1(a) is designed through precision mechatronics and bio-medical integration processes to offer total weight

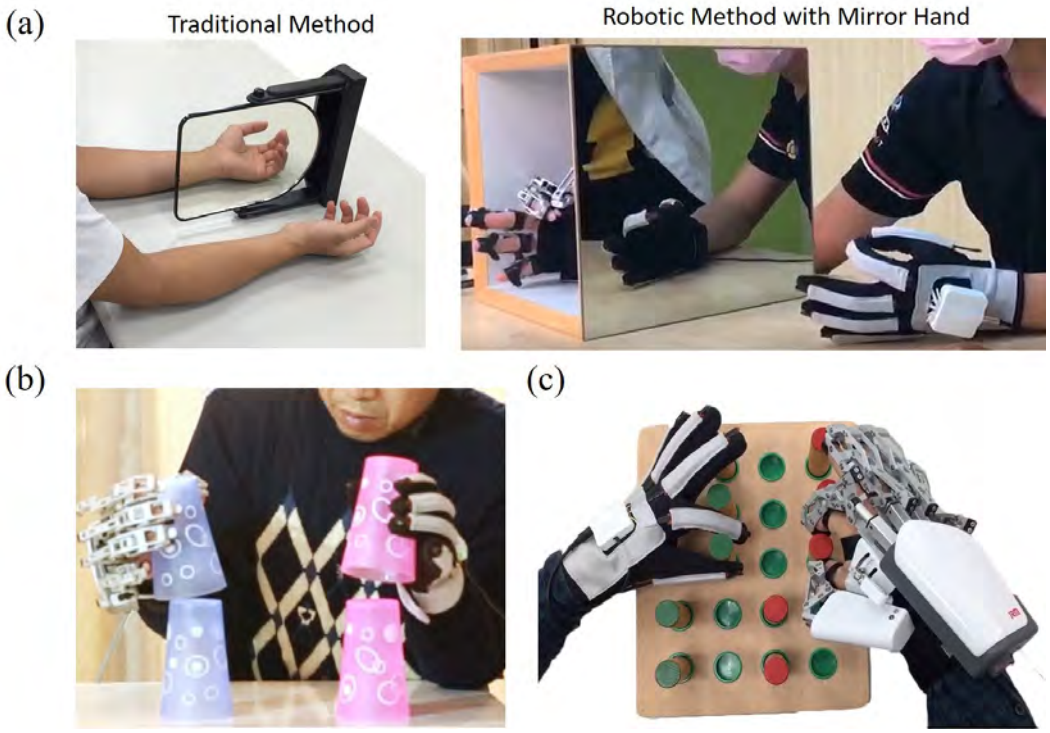

Figure 2. (a) Comparison of traditional mirror theory and the robotic method with the Mirror Hand. Examples of the Mirror Hand helping patients in (b) grasping, (c) nipping as well as placing objects.

of less than 800 grammes, significant reduction of uncomfortable pressure on patients, and to provide certified biocompatibility when worn by patients. The exoskeletal hand worn on a stroke patient's impaired hand can be controlled by the sensor glove as shown in Figure 1(b) which is worn by the patient's healthy hand or the therapist's hand. This sensor glove is also designed with biocompatible but breathable materials offering comfort and light weight of 107 grammes for convenient wearing and operating. The finger movements acquired by the sensor glove are directly fed into the light-weighted control box (125 grammes) as shown in Figure 1(c), with its signals processed by a well-engineered signal processing algorithm to identify the proper hand/finger movements and then to duplicate the movements in exoskeletal hand. With such portable and precise designs, the Mirror Hand certainly removes the traditional rehabilitation restrictions and enables patients to conduct rehabilitation exercises beyond rehabilitation centres.

With these functions, sensing technology is utilised in the Mirror Hand provides conventical Continuous Passive Movement (CPM) model and bimanual therapy. With the Mirror Hand device, patients can guide the impaired or affected hand using their own healthy hand to perform mirror therapy. As shown in Figure 2(a), the affected hand is simply placed behind the mirror without any movement, in the traditional mirror therapy exercise, while the healthy hand moves for the patient to see the reflection in the mirror to stimulate reconstruction of neurons. With the Mirror Hand device, the traditional therapy method is preserved but with enhancement of actual movement in the impaired hand with the robot. In the bimanual rehabilitation mode, the Mirror Hand allows patients to grasp big objects such as cups as illustrated in Figure 2(b) and to grip small objects such as the coloured cylinders or screws as shown in Figure 2(c).

This innovative robotic device has obtained Taiwan FDA certification, passed ISO 13485:2016 regulations, and recognised with 2018 National Innovation Award. By applying the robot-assisted rehabilitation technology, it is hoped that stroke patient finger muscle strength and joint flexibility can be improved. This could avoid the phenomenon of muscle atrophy and joint sclerosis which occurs from long-term fixation in the same posture, neuromuscular disorders and diseases that lead to permanent loss of hand functions.

NATIONAL TSING HUA UNIVERSITY
DEPARTMENT OF POWER MECHANICAL ENGINEERING

Jen-Yuan (James) Chang
Distinguished Professor
Department of Power Mechanical Engineering
National Tsing Hua University, Taiwan
Tel: +886 3 574 2498
jychang@pme.nthu.edu.tw
http://www.pme.nthu.edu.tw/files/14-1265-74003,r4027-1.php?Lang=en

Redefining efficiency based on what matters to cancer patients

Redefining efficiency based on what matters to cancer patients is placed under the spotlight here by All.Can, including identifying opportunities for change

Efficiency has become something of a buzzword in healthcare recently – but the patient perspective is too often forgotten in definitions of efficiency. All.Can surveyed nearly 4,000 cancer patients from over 10 countries to ask them where inefficiencies occurred most in cancer care[1] – with the aim of building these insights into future definitions and efforts to improve efficiency in cancer care.

While most reported that their needs were sufficiently addressed during their care, they also highlighted some specific areas where improvements were needed.

Four opportunities to improve cancer care:

1. Ensure swift, accurate and appropriately delivered diagnosis: When asked to select one area of cancer care where they experienced the most inefficiency, 26% of respondents chose diagnosis – more than any other area of cancer care. Among respondents whose cancer was diagnosed outside of a screening programme, 32% said their cancer was diagnosed as something else, either once or multiple times.

2. Improve information-sharing, support and shared decision-making: Respondents expressed the need for better information and support – especially after their phase of 'active treatment' was over. Some 39% felt they had inadequate support to deal with ongoing symptoms and side effects, while 35% felt inadequately informed about how to recognise whether their cancer might be returning or getting worse.

"I think we do not take the aftermath into account enough. Life becomes different after [treatment] and many 'little sores' occur, with which one must live."
(Respondent from Belgium)

3. Make integrated multidisciplinary care a reality for all patients: Respondents asked for more focus on the emotional and psychological impact of cancer and better integration of allied health and complementary services into their care. Cancer nurse specialists were often cited as playing an essential 'navigator' role. While 69% of respondents said they needed psychological support during or after their cancer care, 34% of those who needed it said such support was unavailable.

"I needed someone to talk to; I was given written information." (Respondent from France)

4. Address the financial implications of cancer: Respondents frequently spoke of the financial impact of having cancer – not just in terms of having to pay for components of their care themselves, but also the cost of travelling to appointments, childcare or household help, lost income and difficulties in getting insurance, mortgages or loans as a result of their cancer diagnosis. Over a quarter of respondents (26%) reported that they had suffered financially due to loss of employment related to their cancer.

"I was not really given any info about how long to recover from chemo or returning to work. I had to devise my own return-to-work plan." (Respondent from Canada)

Why these findings matter

The findings from this survey are consistent with other reports in the literature.[2-5] Policymakers, healthcare professionals and all stakeholders need to listen to these perspectives and build them into efforts to improve cancer care.

All.Can member Christobel Saunders, Professor of Surgical Oncology at the University of Western Australia, said of the findings: "It is so important that, as physicians, we listen to what patients are telling us in this

survey. Each of the areas identified represents an opportunity to improve care for patients and provide truly patient-driven care."

Acting on these findings can make a real difference to patients, their families and healthcare systems. For example:

- For many cancers, early diagnosis can improve survival.[6] By contrast, late diagnosis and misdiagnosis can lead to delays in treatment, poorer survival and higher costs of care.[7, 8]

- Fulfilling patients' needs for information is associated with improved treatment adherence[9-11] and better clinical outcomes.[11, 12] Information can help patients feel more in control of their disease, reduce anxiety and help create realistic expectations for their care.[12, 13]

- Having cancer nurses may bring overall savings to healthcare systems, with one report in the United Kingdom suggesting that introducing specialist nurses into the cancer care pathway could save about 10% of cancer expenditure.[14]

- There is growing evidence that many patients face a 'cascade of financial burden' due to cancer: for example, an Australian study found that cancer patients may spend up to 15% of their lifetime income on their disease.[15] Social costs – namely lost productivity and caregiver time – represent 60% of the total cost of cancer.[16] Creating protective health and social policies that support those patients who can return to work and protect them from financial insecurity is therefore crucial.

About the survey:

The All.Can patient survey was conducted in 2018 by Quality Health, with close input from All.Can members. A total of 3,981 people from over 10 countries responded to the survey (specifically, in Europe, North America and Australia). The survey was open to current or former patients with any type of cancer. For more information, see https://www.all-can.org/what-we-do/research/patient-survey/ ■

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All.Can
secretariat@all-can.org
www.all-can.org
www.twitter.com/AllCanGroup

Swansea University Medical School's Director of Research releases 100th cancer research paper

After a career spanning more than 20 years, a Swansea University Professor's passion for research is as 'strong as ever', as he marks a very notable achievement – the release of his 100th paper on cancer

Professor Gareth Jenkins, Director of Research at Swansea University Medical School, says his most recent publication – which explains how in the future oesophageal cancer could be diagnosed with a £30 blood test – is one of the most significant of his career.

His involvement in this latest study was fuelled by a long-standing interest in the molecular basis of cancer in the gastrointestinal tract, particularly the pre-malignant condition Barrett's Oesophagus.

The research was published in Nature Scientific Reports, and Professor Jenkins also wrote about the findings for leading research news website The Conversation.

Professor Jenkins said: "Many researchers will produce many more papers than this during their careers but I thought it was a nice coincidence that my 100th paper came out as Swansea University prepares to celebrate its own Centenary in 2020."

Professor Jenkins's role as Director of Research at the leading UK Medical School sees him divide his time between his managerial responsibilities and leading his own research – and he says his passion for research is still as strong as ever. "I do really like talking to the students. I still get a real buzz out of the research, it is the thing that keeps me going."

Professor Jenkins first came to Swansea as a PhD student back in 1993 to work with Professor Jim Parry, a leading expert in DNA mutations.

"Mutations cause cancer so if you can reduce the amount of mutations that you accumulate during your lifetime you reduce your risk of getting cancer. Take smoking, cigarette smoke causes mutations which is why it leads to cancer, the more you smoke the greater your risk. "The thrust of my career to date is trying to develop new ways of measuring those DNA mutations."

This work plays a key role in maintaining the University's reputation, especially as it prepares for the Research Excellence Framework (REF) assessment of the quality of research in UK higher education institutions which takes

Professor Gareth Jenkins, Director of Research at Swansea University Medical School

place in 2021. This assessment is essential to secure the continuation of a world-class, dynamic and responsive research base across the UK.

Last time this was carried out in 2014 Swansea University was ranked 23rd in the UK and the Medical school was ranked 2nd in Unit of Assessment 3, for the quality of its research. Some of that success is down to research into mutations carried out by Professor Jenkins and his colleagues, including Professor Shareen Doak who leads the University's In Vitro Toxicology Group.

Together they have been at the forefront of work to develop lab-grown human cells to use when studying whether test compounds cause mutations and their link to cancer. This work aims to study mutation in human models rather than use animals for testing. He said: "This latest paper, led by Hasan Haboubi, gave me an opportunity to combine work in DNA mutations from our animal-alternative research and use those kinds of approaches to study patients with oesophageal cancer and Barrett's oesophagus. Its publication is the culmination of six years of hard work."

As one of the pioneers of the University's Medical School Professor Jenkins is delighted to have played a part in its remarkable growth and now has an office in the ILS building that he helped to design.

"After I completed my doctorate, I considered leaving Swansea, but the Medical School was about to start and I could see this was going to be a big development with great opportunities for future research," he said.

"When I was a PhD student in the Genetics department at Swansea there were 20 of us, now the Medical School has 200 PhD students.

"It has seen enormous growth in a relatively short space of time and we're proud we can provide great opportunities for research." Swansea University will celebrate its Centenary on July 19, 2020. Throughout the Centenary year, the University will commemorate the academic success and proud achievements of Swansea's current and former staff, our students, and alumni. Also, in 2020, Swansea's Medical School will celebrate 50 years of teaching Genetics and Biochemistry.

To find out more about the Medical School visit:

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Swansea University Medical School
Tel: +44 (0)1792 295 111
study@swansea.ac.uk
www.swansea.ac.uk/medicine
www.twitter.com/swanseamedicine

Ductal Carcinoma in Situ: Gaining new Biological Insights from Multiscale Mathematical Modeling

Joseph D. Butner, Vittorio Cristini, Zhihui Wang
Mathematics in Medicine Program, Houston Methodist Research Institute, Houston, TX 77030, USA

Breast cancer is the most frequently diagnosed form of cancer in the United States, with 239,109 new cases diagnosed in 2014 alone (the most recent year complete statistics reported) [1], and roughly 12% of women will receive a positive diagnosis within their lifetime. Carcinomas in situ constitute roughly 20% of all cancers of the breast [2], and the majority (~83%) occur within the mammary gland duct, known as ductal carcinoma in situ (DCIS) [3]. DCIS is a cancer of the luminal epithelial cells of the mature mammary gland, and is characterized by loss of heterogeneity of the luminal cells composing the inner layer of the mammary gland duct, resulting in dysregulated proliferation into the duct cavity. DCIS is a stage zero pre-invasive cancer (as it remains contained within the duct), and has been associated with increased risk of invasive or recurring breast cancer [2].

The mammary duct is a bilayered structure, composed of epithelial cells surrounding an open duct cavity (Fig. 1A). Within the mammary gland, cells are phenotypically distinct based on the presence or lack of estrogen receptor α (estrogen receptor positive: ER+) or fibroblast growth factor (FGF) receptor, and also based on stem, proliferative, or terminally differentiated phenotype (Fig. 1B). Paracrine estrogen signals to ER+ cells and results in upregulation of amphiregulin (AREG) production in these cells, cascading an AREG epithelial to stromal paracrine mechanism, where AREG upregulates FGF production in the stroma. FGF then reenters the mammary epithelium and signals to the estrogen receptor α negative (ER−)/FGF receptor positive (FGFR+) cells. This pathway plays an important role in mature gland maintenance and, when abnormal, may contribute to breast cancer [4]. As many as 70% of all breast cancers are ER+, and loss of function in estrogen receptor α has been shown to be associated with transition to DCIS [5]. Aberrations in the FGF receptor have also been discovered in breast cancer, and are often associated with increased FGF signaling and negative patient prognosis [4].

We have developed a multiscale agent-based model of DCIS, and are using it to gain new biological insights on early-stage DCIS ductal invasion into the duct cavity (we characterize this by the ductal advance rate), as influenced by the cell-scale population dynamics, phenotypic distributions, and important molecular signaling pathways involved. This is accomplished mathematically through a hybridized discrete cell-scale model, where individual cells are represented as discrete objects (these are called agents; Fig. 1A-C), combined with a continuum molecular scale model, where molecular movement and local concentrations are represented as partial differential equations and solved using standard numerical methods (Fig. 1D) [6]. By combining and explicitly linking these two modeling scales through a bidirectional feedback mechanism, our model allows for study of how cell populations are influenced by the underlying molecular concentrations, thereby yielding new insights into the early stages of DCIS development. Our model includes many of the most well-established factors in DCIS, allowing for detailed parameter perturbation analysis studies, including the effects cell hierarchies, cell proliferation rates, rates of molecular uptake or release, and sensitivities to molecular signaling. We also include other key biological consequences of the dysregulated growth patterns in DCIS, including hypoxia and necrosis due to lack of vasculature within the DCIS population and high cell density induced quiescence, which can inhibit cell proliferation.

In our ongoing studies, we are exploring the roles of cell phenotype hierarchies,

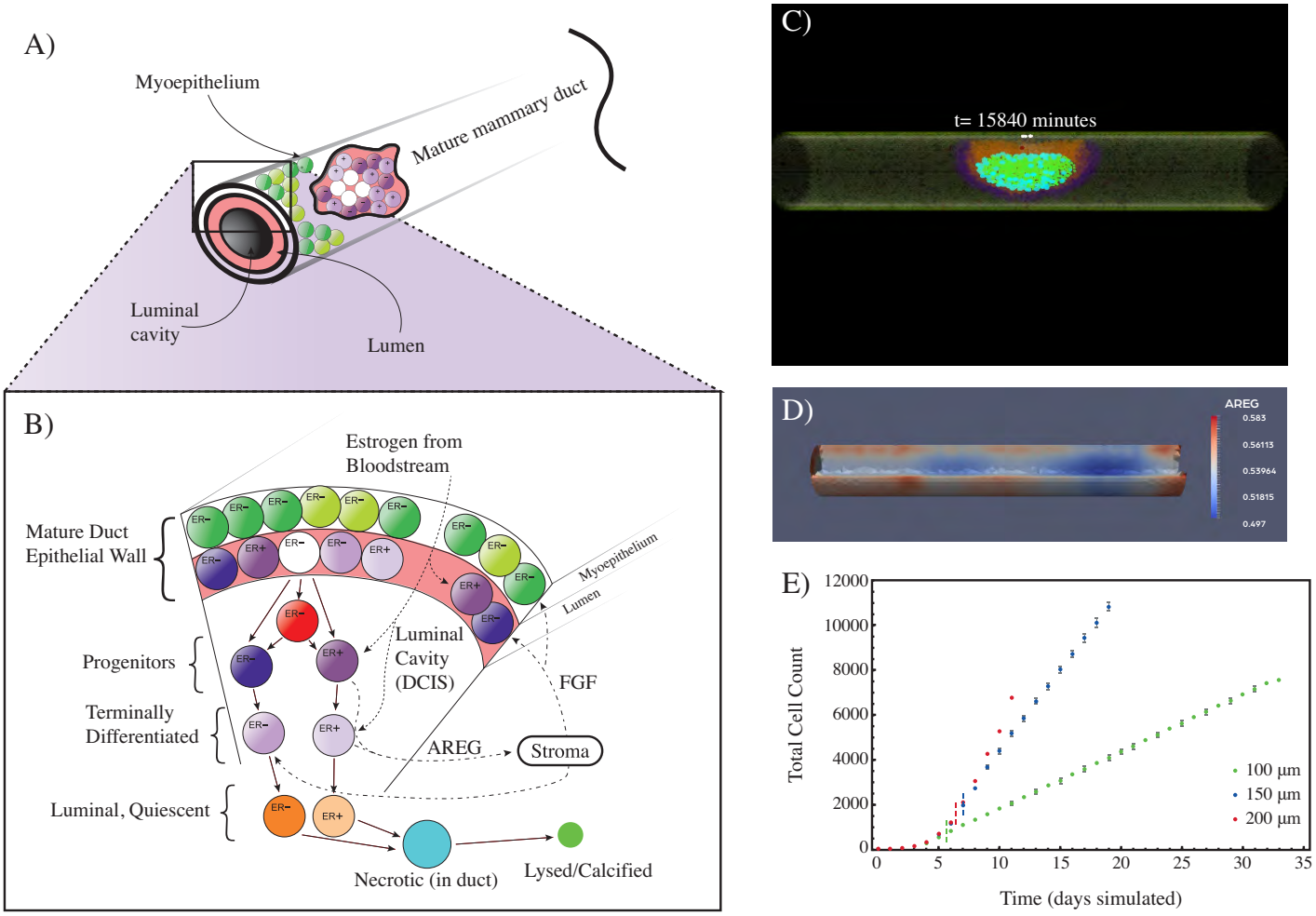

Figure 1: Model schematic, computational domain, and example simulation results. A) The mature mammary gland duct is composed of an outer myoepithelial layer and an inner luminal layer surrounding the duct cavity. B) Cross-sectional schematic of a duct section shows DCIS phenotypic hierarchy and signaling pathways. Estrogen from the bloodstream signals to the ER+ population and upregulates proliferation. These cells are stimulated to produce AREG, which leaves through the duct boundary and into the stroma, upregulating production of FGF back into the duct that upregulates proliferation in the ER− phenotype. Cells may become quiescent due to high cell density, which can also result in local hypoxia, leading to necrotic cell death. C) An example view of DCIS 11 days after DCIS initiation; the mature duct cells and healthy DCIS progenitors are shown as transparent so the stem phenotype, as well as hypoxia and calcification internal to the DCIS may be seen clearly. D) An example continuum numerical solution is shown for AREG concentrations within the duct (red: high concentrations; indicates localized AREG production). F) Total cell count over time for three duct sizes: 100, 150, and 200 µm internal diameter. DCIS cell population expansion occurs over two distinct phases: early exponential growth due to population doublings occurring once per cell cycle, followed by a linear growth phase (transition times between phases indicated by dashed lines, colors correspond to figure legend; found to be 5.6, 7.0, and 6.38 days in the 100, 150, and 200 µm ducts, respectively).

cell decision pathways, and molecular signaling pathways in DCIS development. Agents are bound by a set of rules that determine their actions, including requiring sufficient time to complete all phases of the cell cycle before they may proliferate again, requiring sufficient local oxygen and endocrine/paracrine molecular concentrations to avoid hypoxia and stimulate mitosis, and rules that determine when they are unable to further divide and if cells will die due to apoptosis or hypoxia. In the model, these values are set based on literature reported values, and they may be perturbed to study the effects of breaks in the normal microenvironment on the early stages of DCIS.

Simulation results revealed that DCIS cell population expansion and associated ductal advance rates occur in two distinct phases, characterized by an early exponential population expansion followed by a long-term steady linear phase of population expansion (vertical lines, Fig. 1E). We further found that the rates were tightly regulated by endocrine and paracrine signaling intensity, as well as by the effects of cell density induced quiescence within the DCIS population. Local sensitivity analysis revealed that DCIS progression rates are most sensitive to cell cycle times, and that upstream estrogen

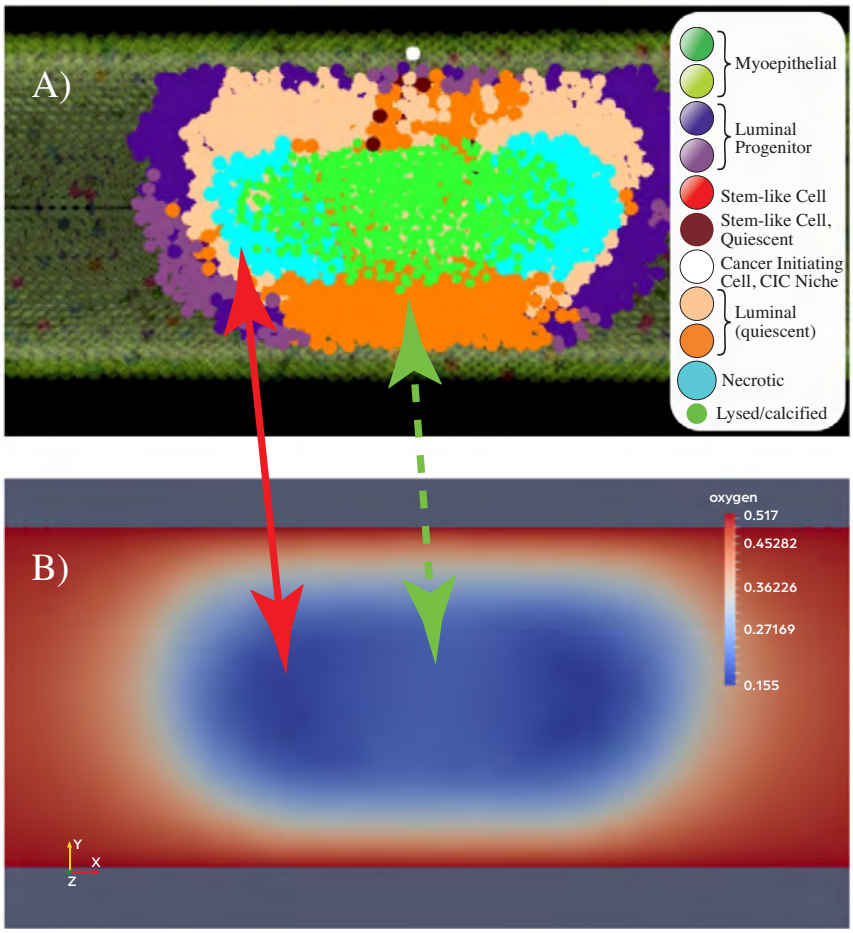

Figure 2: Necrosis acts as a partial relief mechanism for hypoxia. A) Cross sectional view of a section of DCIS with axial necrosis and cell lysis (inset: cell type legend), with the corresponding oxygen solution profile in panel B). Lowest oxygen concentrations were observed in the location of necrotic agents in the DCIS population, following the leading edge of DCIS (panel A, light blue agents and red arrow). In regions of cell lysis and calcification (green agents), oxygen concentrations are observed to partially rebound (green arrow, dashed), due to the relief mechanism of necrosis and calcification through reduction of oxygen consumption at these locations.

signaling has a greater effect than the downstream effects of the AREG–FGF epithelial to stromal pathway. Moreover, it was observed that mixed phenotype DCIS offers a mechanism to overcome molecular signaling bottlenecks, resulting in a cell population shift to the uninhibited phenotype. In all cases, molecular signaling pathways exhibited tight control over cell proliferation events, demonstrating how disruptions in these mechanisms can lead to dysregulated growth and DCIS.

We observed that cell death from necrosis in regions of sustained hypoxia acts as a hypoxia relief mechanism, allowing local oxygen concentrations to rebound and ensuring the remaining cancer population is sufficiently oxygenated, as well as potentially allowing a subset of hypoxia resistant cells to survive until local oxygen concentration recovery. We expect this may play a key role in the natural selection mechanism for a hypoxia-resistant phenotype in vivo, where hypoxia-resistant cells are able to outlast the necrotic transition of their hypoxia-susceptible neighbors long enough to benefit from the observed rebound in local oxygen concentration. Interestingly, we consistently observe a predictable, regular distance between the axial extent of calcification and the leading edge of the tumor. This may allow us to make predictions of an effective surgical margin around ducts where calcification is observed, as the majority of DCIS cases are diagnosed by observation of calcification via mammography [7]. This model may serve as a useful tool to study the cell-scale dynamics involved in DCIS initiation and intraductal invasion, and may provide insights into promising areas of future experimental research.

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HOUSTON Methodist LEADING MEDICINE

Joseph D. Butner
Vittorio Cristini
Zhihui Wang
Mathematics in Medicine Program
Houston Methodist Research Institute
Houston, TX 77030, USA

Elucidating the pathogenesis of paediatric cancers

Prof Nicolo Riggi and Prof Ivan Stamenkovic from the University of Lausanne share their thoughts on the pathogenesis of paediatric cancers

Paediatric malignancies differ from adult cancers in both their pathogenesis and behaviour, largely due to their distinct genetic and epigenetic underpinnings. In contrast to the majority of adult cancers, which develop years to decades following transformation of a single cell, paediatric cancers, particularly those that occur in the first few years following birth, emerge far more rapidly. Whereas most adult cancers accumulate a multitude of genetic mutations by the time they become clinically detectable, the majority of paediatric cancers are genetically "quiescent", meaning that they harbour few and sometimes even only single mutations.

Numerous mutations can contribute to adult cancer growth and different mutations may drive the progression of any given cancer at different stages of its evolution. Determining which mutation(s) is/are driving an adult cancer at the time of diagnosis can, therefore, be challenging. In contrast, mutations responsible for paediatric cancer development are easier to identify, which facilitates exploring the pathogenesis of these tumours and obtaining clues as to potential therapeutic targets and options.

Although genetic mutations have long been thought to play the key role in the pathogenesis of cancer, it is becoming increasingly clear that in many malignancies, posttranslational and epigenetic modifications may play an equally important role, sometimes even dominating that of the genetic mutations. "Epigenetics" was originally coined to describe heritable changes in a cellular phenotype that were not due to alterations in DNA sequence. It is most commonly used to describe chromatin-based events that regulate DNA-templated processes such as gene expression.

Chemical modifications, such as methylation of DNA within gene promoters and of acetylation and methylation of histones, which are proteins intimately associated with DNA, provide some of the dominant epigenetic mechanisms that control gene expression. Histone modifications determine whether DNA segments assume a compact or relaxed structure. Activating histone marks are associated with relaxed DNA that is accessible to transcription factors, allowing expression of genes within the corresponding DNA segments. Repressive histone marks induce DNA compaction, rendering it inaccessible to the transcriptional machinery and resulting in the silencing of genes located in the corresponding DNA segments. As the genes in question may control cell division, growth and survival, epigenetic regulation of their expression may constitute key determinant of cancer emergence, maintenance and resistance to treatment.

Increasing evidence suggests that epigenetic changes play a critical role in the development of paediatric cancers. Many solid paediatric malignancies, particularly of bone and soft tissues, known as sarcomas, arise as a result of unique reciprocal chromosomal translocations that give rise to fusion genes, which encode fusion proteins found only the in the cancer cells. These fusion proteins provide a diagnostic signature for these particular types of cancer, and, more importantly, are uniquely responsible for their pathogenesis.

In the majority of cases, the fusion proteins behave as aberrant transcription factors or transcriptional regulators. They alter the gene expression repertoire of the cells, augmenting the expression of genes that promote cell survival and growth and, in some cases, silencing those that induce differentiation and quiescence. To execute their functions, these aberrant transcription factors may form complexes with chromatin-modifying enzymes and instruct them to reconfigure DNA structure, opening domains that in normal cells remain compact and, therefore, inaccessible to transcription, while condensing domains that are open in normal differentiated cells.

Chromatin modification may thus be harnessed to implement critical changes in the gene expression profile of the cells, rendering them more susceptible to uncontrolled division, inhibiting their differentiation and

maintaining them in an undifferentiated, pluripotent, state, which recapitulates features of normal stem cells. Cancer-associated fusion protein-driven chromatin modification may, therefore, mimic a developmental state and establish a cellular hierarchy within the tumour, which recapitulates that of normal developing tissues, albeit in an aberrant fashion.

Whereas the presence of the aberrant fusion proteins can provide the means to dissect the mechanisms underlying the development of the corresponding tumours, understanding paediatric cancer development also requires identification of the cells from which these tumours originate. Most normal cells are resistant to transformation. When a mutation that activates an oncogene occurs in a differentiated cell, the cell undergoes what is referred to as oncogenic stress, which causes the cells to stop proliferating and guides them toward a state of permanent growth arrest known as senescence. Senescence thus constitutes a powerful tumour suppressive mechanism and a safeguard against transformation.

However, some cells, particularly stem cells, are constantly engaged in the cell cycle, which requires suppression of some of the key growth inhibitory genes. These cells thereby already display some of the properties that transformed cells adopt. Various types of stem cells, from embryonic stem cells to more lineage-committed variants, are more susceptible to transformation than differentiated cells and may constitute the origin of a variety of cancer types.

Although transformation can occur in a differentiated cell, it requires reconfiguration of the cells state, referred to as reprogramming, that many potential oncogenic events may not be able to induce. A specific oncogenic event may first need to alter the chromatin structure, reprogramming the cell to acquire stem cell features, including the suppression of growth inhibitory genes, to provide permissiveness for transformation. In contrast, an oncogenic event that occurs in a stem cell may not need to induce reprogramming as permissiveness for transformation may be associated to the pluripotency with which the cell is endowed.

> "Although genetic mutations have long been thought to play the key role in the pathogenesis of cancer, it is becoming increasingly clear that in many malignancies, posttranslational and epigenetic modifications may play an equally important role, sometimes even dominating that of the genetic mutations."

We are pursuing the elucidation of the mechanisms that underlie paediatric cancer emergence, maintenance and progression. Our goal so to identify those mechanisms that may be targetable from a therapeutic standpoint. We are focusing on paediatric sarcomas whose pathogenesis is driven by unique fusion proteins described above. We have identified populations of committed stem cells, known as mesenchymal stem cells, which give rise to fatty tissue, bone, cartilage and other connective tissues, as the most likely cells of origin of several sarcomas. We have begun to shed light onto the mechanisms by which the fusion proteins associated with defined paediatric sarcomas transform these particular cells and to unravel the events that drive the development and progression of the corresponding tumours. Because they are unstructured proteins, the aberrant transcription factors that underlie sarcoma pathogenesis cannot be readily neutralised by specific drugs.

It is, therefore, essential to identify the downstream events that they initiate or key molecules with which they interact and that support their function, which could be amenable to targeting by newly designed or even repurposed drugs. We have identified some of the key posttranslational and epigenetic mechanisms induced by the fusion proteins that underlie sarcoma development and are now exploring approaches to target these mechanisms and develop new and effective ways to treat the corresponding tumours, which currently bear poor prognosis, despite aggressive multimodal therapy.

Prof Ivan Stamenkovic
Professor of Pathology, Director – Experimental Pathology Service
Centre Hospitalier Universitaire Vaudois (CHUV) University of Lausanne
Tel: +41 21 314 7136
Ivan.Stamenkovic@chuv.ch
www.chuv.ch

The prevalence of diabetes in the African region

In this in-depth interview with Jean-Marie Dangou from the WHO Regional Office for Africa, we find out exactly what the prevalence of diabetes is in the African region, including the lack of access to proper treatment and diabetic medications and what is being done to address this

About 422 million people worldwide have diabetes, particularly in low-and middle-income countries. Did you know that diabetes is one of the leading causes of death in the world? Simply put, there are two types of diabetes: Type 1 diabetes (lack of insulin) and Type 2 diabetes (ineffective use of insulin). We find out more about diabetes in the African region in a conversation with Pr. Jean-Marie Dangou, Coordinator, Noncommunicable Diseases Primary Prevention (NPP), Noncommunicable Diseases Cluster at WHO Regional Office for Africa.

In this interview, we find out what diabetes is and why it has become a new priority and what surveys tell us about the extent of diabetes in the African region. Amongst the numerous insights offered here, we also learn about the lack of access to proper treatment and diabetic medications, especially insulin, resulting in avoidable complications and what is being done to address this.

While infectious diseases, HIV/AIDS and poverty have traditionally dominated the African region, to what extent has diabetes now become a new priority?

Over the past three decades, the occurrence of diabetes mellitus has risen dramatically in all countries of all income levels. The prevalence of diabetes in sub-Saharan Africa, similar to trends being seen worldwide, is rapidly rising. The sub-Saharan African region is expected to see the largest percentage increase in the incidence of diabetes in any region in the world. In 2015, the International Diabetes Federation (IDF) estimated that there were 14.2 million people with diabetes in sub-Saharan Africa.

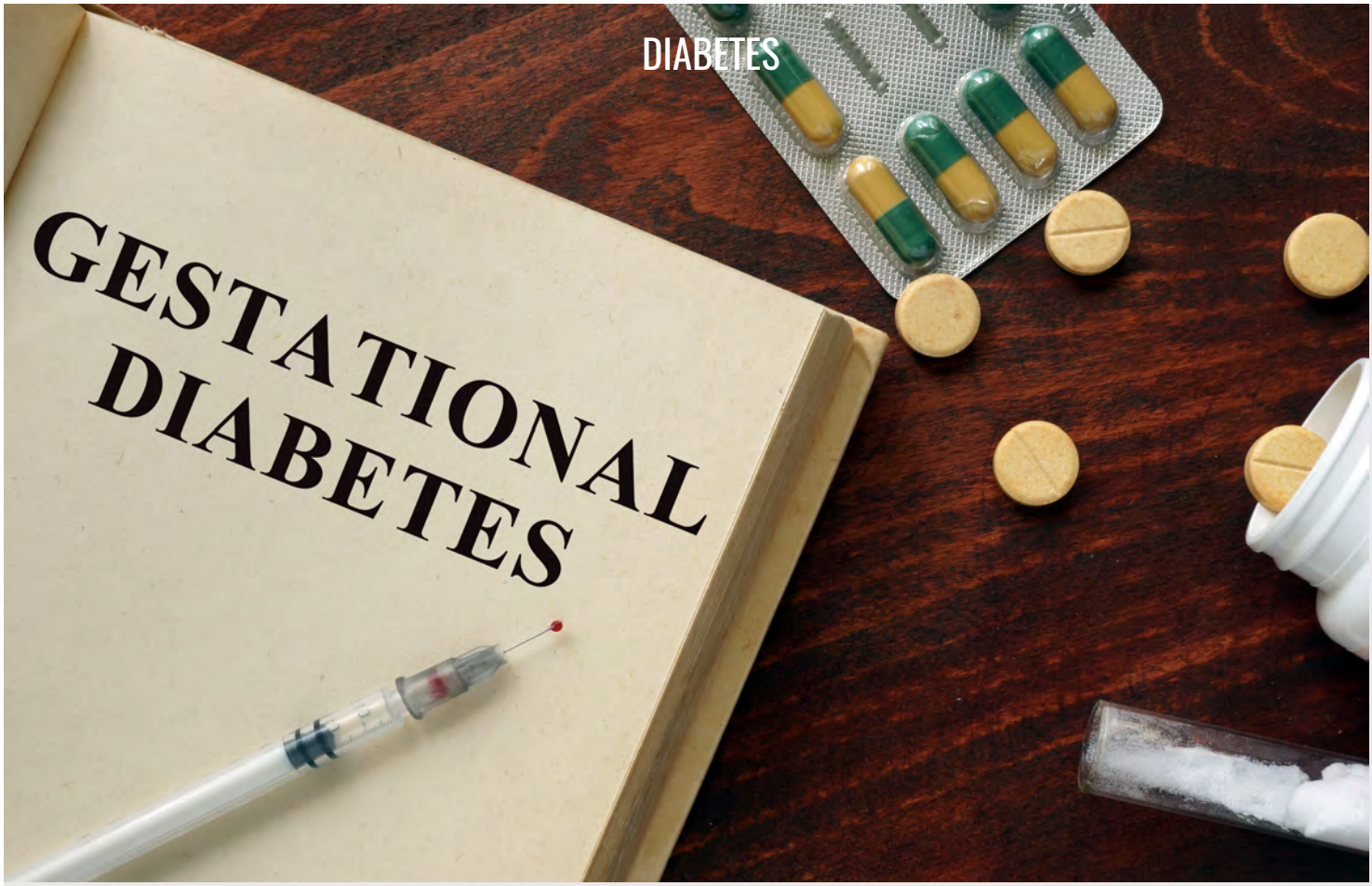
Prevalence is highly varied between countries, with prevalence ranging from a low of 0.6% in Benin to a high of 18.2% in Réunion. There is also great variability in rural versus urban prevalence with urban areas facing the brunt of the burden. The wide variation in diabetes prevalence can be explained partly due to regional differences in lifestyle and body mass index. If we do not act now, this figure will increase by 162% by 2045. Africa is the region with the highest percentage of undiagnosed people – 70% of people with diabetes do not know they have it. Diabetes caused about 312,000 deaths in 2017 and 3 out of 4 (73%) deaths due to diabetes were people under the age of 60. This rise is due to ageing populations and lifestyle changes – including unhealthy diets and lack of physical activity. Overweight and obesity are the strongest risk factors for Type 2 diabetes, cardiovascular disease and other noncommunicable diseases.

What is diabetes and what are the main symptoms?

Diabetes mellitus is a serious, persistent disease in which blood sugar is elevated. Over a period of time raised blood glucose may lead to serious damage to nerves and blood vessels. The disease may go undiagnosed for years until complications have arisen. Symptoms include excessive urination and thirst, constant hunger, weight loss, vision changes and fatigue. Some people may suffer from signs and symptoms of heart attack or limb gangrene. If not well-controlled, diabetes may cause blindness, kidney failure, lower-limb amputations, heart attacks, strokes and other complications.

How would you summarise the three different types of diabetes?

There are three main forms of diabetes – Type 1 diabetes; Type 2 diabetes and gestational diabetes. Type 1 diabetes, previously known as insulin-dependent, juvenile-onset or childhood-onset diabetes, is characterised



by deficient insulin production by the pancreas. People with Type 1 diabetes require daily administration of insulin to utilise the glucose in their blood. Without insulin, they cannot survive. The cause of Type 1 diabetes is not known and it is currently not preventable. Type 2 diabetes formerly called non-insulin-dependent or adult-onset diabetes occurs when the body can no longer effectively use insulin. A vast majority of people with diabetes (over 90%) have this form of the disease. Some risk factors for Type 2 diabetes – such as genetics, ethnicity and age – are not modifiable. Others, such as being overweight or obese, unhealthy diet, insufficient physical activity, alcohol consumption and smoking are modifiable through behavioural and environmental changes. Type 2 diabetes was once seen only in adults, but it has begun to occur in children in recent years. Gestational diabetes is a temporary condition that occurs in pregnancy and carries long- term risk of Type 2 diabetes. Approximately one in seven births are affected by gestational diabetes, a severe and neglected threat to maternal and child health. Many women with gestational diabetes experience pregnancy-related complications including high blood pressure, large birth weight babies and obstructed labour.

What have surveys shown about the extent of diabetes in the African Region?

In 2017, the top five countries for the number of people with diabetes (18-99 years) were Ethiopia, South Africa, Democratic Republic of Congo, Nigeria and Tanzania. Currently, the prevalence of diabetes in the African region is estimated to be 7.1 % compared to 3.1% in 1980. Early diagnosis, detection and the management of Type 2 diabetes reduce the development of complications such as visual impairment and blindness. Management of Type 2 diabetes involves the control of blood glucose through a combination of dietary, physical activity, counselling and appropriate medicines if necessary. The risk of developing Type 2 diabetes and its complications could be significantly reduced by maintaining a healthy body weight, engaging in sufficient physical activity, eating a well-balanced diet low in sugar and fat but supplemented with fresh fruits and vegetables on a daily basis, as well as avoiding tobacco and harmful use of alcohol throughout a person's life. A lot needs to be done in the African region to stem the tide of rising noncommunicable diseases including diabetes.

What are the issues around a lack of access to proper treatment and diabetic medications, especially insulin, resulting in avoidable complications? What is being done to address this?

Unfortunately, in many African settings, half the people living with Type 2 diabetes are unaware of their disease

and therefore not receiving treatment. Early diagnosis and treatment are important for preventing complications of diabetes. Since diabetes can potentially strike any family, awareness of the signs, symptoms and risk factors is important to help detect it early. Diabetes treatment usually requires daily doses of insulin. This can lead to catastrophic expenditure for people with diabetes and their families when they have to pay out of their own pockets for their treatment. Diabetes can push families into poverty if breadwinners with diabetes become disabled or lose their life prematurely. Diabetes is also a huge burden on the health care system and the national economy. I would like to call upon governments to accelerate the prevention and control of diabetes and other non-communicable diseases by adopting policies, legislation and programmes that promote a healthy diet, physical activity and reduce exposure to tobacco and harmful use of alcohol.

Tell us where you see diabetes in the region heading by 2030?

The number of diabetic patients is expected to increase to 34.2 million patients by 2040. Although the immediate needs of the population already facing diabetes are dire, there exists an equally important need to introduce policy designed to encourage the creation of nutritious food environments and avoid emerging food environments that are being flooded with obesogenic/diabetogenic foods (sugar-sweetened beverages, highly processed foods, etc.). This nutrition transition is fuelling the dramatic rise in diabetes prevalence in urban areas that are shifting toward a more western, sedentary style of life. Although this nutrition and lifestyle transition does not seem to have reached many rural sub-Saharan African settings yet, the extension of this trend is inevitable as the economic growth of sub-Saharan Africa continues to increase. In addition to a nutritious food environment, education about healthy eating and physical activity needs to be implemented at all levels, targeting children and adults as well as urban and rural markets. To identify the unique prevention strategies needed for rural areas, contextualised, culturally adapted research needs to be supported to investigate the dietary patterns that may be increasing the risk for diabetes. Estimation of the costs associated with diabetes is crucial to make progress towards meeting the targets laid out in Sustainable Development Goal 3 set for 2030. The studies included in this review show that the presence of diabetes leads to elevated costs of treatment which further increase in the presence of complications. The cost of drugs generally contributed the most to the total direct costs of treatment.

Thank you. Is there anything you would like to add?

This region faces unique challenges in combating diabetes – lack of funding, lack of availability of studies and guidelines specific to the population, lack of availability of medications, differences in urban and rural patients and inequity between public and private sector health care. Because of these challenges, diabetes has a greater impact on morbidity and mortality related to the disease in sub-Saharan Africa than any other region in the world. In order to address these unacceptably poor trends, contextualised strategies for the prevention, identification, management and financing of diabetes care within this population must be developed.

Combatting diabetes and other NCDs is the business of all – individual; communities; national authorities; development partners; NGOs and INGOs; civil society. Diabetes can be prevented by maintaining normal body weight, engaging in regular physical activity, eating healthy diets that include sufficient consumption of fruits and vegetables and avoiding alcohol consumption and the use of tobacco. We should institute policies and practices across populations and within specific settings (school, home and workplace) that contribute to good health for everyone, regardless of whether they have diabetes. ■

Professor Jean-Marie Dangou
Coordinator, Noncommunicable Diseases Primary Prevention (NPP)
Noncommunicable Diseases Cluster
WHO Regional Office for Africa
Tel: +47 241 39344
dangouj@who.int
www.afro.who.int
www.twitter.com/WHOAFRO

iPDM Goes Europe: The impact on diabetes and patient care

Here, the tangible impact on diabetes patients and their care is thoroughly explored via integrated personalised diabetes management (iPDM)

Treatment inertia calls for an integrated personalised diabetes management: iPDM.

Despite the availability of numerous treatment options, many patients still fail to reach their treatment goals. According to the UK National Diabetes Audit data 2016-2017, only 30% of people with Type 1 diabetes and 67% of people with Type 2 diabetes achieved a HbA1c target of not more than 58 mmol/l (7.5%). This is all the more remarkable as diabetes represents a huge challenge for European societies.

The good news for innovators tackling treatment inertia in people with Type 2 diabetes, is that this disease leaves a huge space for advancing diabetes treatment towards an iPDM. Personalisation is considered key for overcoming treatment inertia and narrowing the well-known discrepancy between drug efficacy, found in well-controlled clinical trials and drug effectiveness, observed in real-world clinical practice (the E2E gap).

iPDM: the conceptual roots

In 2012, Antonio Ceriello and colleagues published a concept paper proposing a structured and iterative six-step process cycle for the implementation of a prototypic iPDM regime:[1]

- Education & training for a structured self-monitoring of blood glucose (SMBG)
- Implementation of structured SMBG
- Upload and documentation of SMBG data
- SMBG data analysis
- SMBG data-based adaption of treatment
- Assessment of treatment efficacy

Repeatedly entering new cycles of iPDM was proposed to realise an iterative approach, enabling a stepwise optimisation of the individual diabetes management.

iPDM-like cycles in diabetes management were taken up in a recent consensus report on the management of hyperglycemia in Type 2 diabetes of the American Diabetes Association and the European Association for the Study of Diabetes.[2]

Real-World effectiveness of iPDM: the ProValue study program

Inspired by the iPDM proposal, the iPDM-ProValue real-world studies were initiated.[3] iPDM-ProValue integrated low-threshold digital tools to prove the effectiveness of a 12-month iPDM regime in people with Type 2 diabetes on insulin therapy. They were designed as prospective, cluster-randomised, controlled intervention trials comparing iPDM in either general medical or diabetes specialised practices to a control group.

Overall the iPDM-ProValue studies indicated that patients following the iPDM scheme achieved better glycemic outcomes. The better reduction of HbA1c after 12 months iPDM vs. usual care (- 0.5%, $p < 0.0001$ vs. - 0.3%, $p < 0.0001$; Diff. 0.2%, $p = 0.0324$) was achieved without any impact on the incidence rate ratio of hypoglycemic episodes. At the same time in the iPDM groups a higher percentage of patients received recommendations to adjust their insulin therapy and experienced more behavioural and lifestyle recommendations throughout the study. Also, the satisfaction of both patients and healthcare providers as well as the adherence of patients to their pre-determined treatment regimens improved in the iPDM groups. iPDM effectiveness was positively affected by the usage of digital tools.

iPDM-GO: from real-world validation studies towards Europe-wide implementation

The recently started iPDM-GO (iPDM Goes Europe) initiative involves a consortium of diverse partners from industry, academia and healthcare administration in Europe. Collectively, the team has extensive expertise and skills in clinical practice, computer science, health psychology, health economics and bioinformatics. Profil is coordinating a workpackage on

"Research in iPDM enhancement, implementation and scalability" and adds expertise in close-to-market clinical research and development.[4]

iPDM-GO takes advantage from the dedicated innovation eco-system provided by the European EIT Health public-private partnership.[5] This is going to facilitate the engagement with all the involved stakeholders which is essential for a successful launch of iPDM. iPDM-GO is dedicated to implementing iPDM, along with an outcomes-based payment model, first in innovative model regions to lay groundwork for expanding these concepts to additional European countries.

iPDM enhancement: for tangible impact on diabetes patients and diabetes care

The iPDM-GO initiative realises an open and collaborative approach. It is answering the challenge of how many people with diabetes still do not achieve their treatment goals – while the costs associated with chronic diseases continue to rise.

iPDM-GO offers opportunities to further enhance iPDM and explore the massive and multi-dimensional scalability of iPDM. Acknowledging the diversity of people with Type 2 diabetes is key for the implementation of iPDM regimens people are able and willing to adhere to. Health economic analysis needs to be applied in order to prove the cost-effectiveness of iPDM evolution.

Patient assessment should integrate the usage of real-world data collected by sensors combined with telemedical tools. Applying machine learning approaches to large epidemiological data sets will help to establish prediction models estimating the individual risk of developing comorbid conditions. Integrating advanced artificial pancreas systems as developed by the CLOSE EIT Health innovation project[6] for a comprehensive monitoring of health and disease signatures will produce a huge amount of real-world data informing iPDM by taking advantage of self-learning control algorithms. Data-driven iPDM feedback loops will trigger an adjustment of therapies, social interventions and behavioural patterns along the lines of patient preferences, new drugs & technologies, treatment guidelines, geography and reimbursement policies, to name a few – leading to an amelioration of treatment inertia and the E2E gap with a tangible impact on the life of diabetes patients and the sustainability of diabetes care.[7]

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Prof Dr Freimut Schliess
Director, Science & Innovation
Profil GmbH
Tel: +49 2131 4018 225
Freimut.Schliess@profil.com
www.profil.com

Turning a corner in the prevention of Type 1 diabetes

Dr Elizabeth Robertson, Director of Research at Diabetes UK explains why 2019 marked turning a corner in the prevention of Type 1 diabetes but adds that there is still more research to be done in this area

This year marked a significant milestone for Type 1 diabetes. After more than three decades of clinical trials, each one providing important learnings for the next, the research community reached the positive outcome they had been waiting for: it was possible to delay the diagnosis of Type 1 diabetes.

This finding has sparked a wave of new possibilities, but importantly it provides much-needed confirmation that tackling the root cause of Type 1 – the immune attack against insulin-producing beta cells in the pancreas – has been the right strategy.

Witnessing Teplizumab, an anti-CD3 antibody, delay the onset of Type 1 diabetes by an average of two years, is the result of a mammoth effort to piece together the underlying pathology of this condition. Each hard-won milestone has been significant; from establishing that the development of Type 1 begins years before the actual diagnosis, to early experiments confirming that anti-CD3 antibodies could prevent Type 1 in mice.

This effort culminated in a small TrialNet clinical trial in 76 people, 44 of whom were given a two-week IV infusion of Teplizumab. The median time to a diagnosis of Type 1 was two years in those receiving a dummy infusion, but four years in those who were given Teplizumab.

That's an average of two extra years free of Type 1 diabetes for some of the participants in this trial. Two years free of insulin therapy, sleepless nights, or the worry of future complications. But before we get too ahead of ourselves, there is more research to be done.

For one, a larger clinical trial is needed to confirm Teplizumab's effects. But the positive results of this phase 2 trial present some challenging questions for the research community. First and perhaps most pressing, is the question of how appropriate would it be for some of the participants to receive a placebo drug, given the beneficial effects of the active drug?

Dr Elizabeth Robertson, Director of Research

Second, who will be recruited to future trials? This small trial focused on people with family members who have Type 1 diabetes, but the majority of people who develop Type 1 don't have a family history – can future trials and recruitment efforts account for this?

And third, will the results translate into the prevention of Type 1 diabetes? It's important to note that this trial was carried out in people with a near 100% chance of developing Type 1 diabetes at some point in their life. While one might hope to move onto those who are at an earlier stage in their development of Type 1, or a lower risk, it's thought that Teplizumab works on an immune system which has already been 'activated' against beta cells, making this challenging.

In addition, it's near impossible to assess the true effects of a drug on prevention in a trial setting, as participants would all need to be followed until death. But perhaps the two-year delay offered by Teplizumab could be extended and – if subsequent trial results lead to a license for those at high risk – future real-world data could paint a clearer picture of Teplizumab's long-term prevention effects.

"This year marked a significant milestone for Type 1 diabetes. After more than three decades of clinical trials, each one providing important learnings for the next, the research community reached the positive outcome they had been waiting for: it was possible to delay the diagnosis of Type 1 diabetes."

There are challenges ahead but they do not lessen this significant milestone. And with insulin therapy nearing its 100-year anniversary, we need more milestones like this. Each step forward in our understanding of how to prevent or delay the onset of Type 1 diabetes brings us closer to finding a cure. A possible future scenario is one where we can combine a treatment to stop the immune attack with another to replace or regenerate lost beta cells. So research must continue.

For now, we're thankful. Thankful to the researchers involved in this discovery who didn't give up, to the healthcare professionals who enable clinical science to happen and most importantly, we are thankful to the thousands of people at risk of Type 1 diabetes who have continued to take part in the research. ■

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Dr Elizabeth Robertson
Director of Research
Diabetes UK
Tel: +44 (0)20 7424 1001
www.diabetes.org.uk
www.twitter.com/erobertson02
www.twitter.com/DiabetesUK

The priorities for tackling viral hepatitis in Africa

In this exclusive interview with Prof Olufunmilayo Lesi, Regional Medical Officer for Viral Hepatitis from the World Health Organization (WHO) Office for the Africa Region, she speaks to us about the priorities for tackling viral hepatitis in Africa

Today, viral hepatitis has become a public health challenge of global proportion. While there are five distinct types of viral hepatitis (A, B, C, D, E), chronic hepatitis B and C cause 96% of hepatitis-related sickness and untimely deaths. Hepatitis D, however, is less common and occurs only in association with hepatitis B. The other viruses (namely hepatitis A & E) are spread via contaminated water and food and result in acute infections and outbreak in areas of inadequate waste disposal and poor sanitation. Having said this, acute infections are often short-lived and are resolved within the space of a few weeks.

In this exclusive interview with Prof Olufunmilayo Lesi, Regional Medical Officer for Viral Hepatitis from the World Health Organization (WHO) Office for the Africa Region, she speaks to us about the priorities for tackling viral hepatitis in Africa. Amongst the many insights given here, we learn how the epidemic of viral hepatitis B and C affects people globally compared to the global HIV epidemic. Also, we find out about the distinct types of viral hepatitis (A, B, C, D, E) and how the virus is picked up and which groups of people it affects the most. We also find out how it is treated.

How does the epidemic of viral hepatitis B and C affect people globally compared to the global HIV epidemic?

The epidemic of viral hepatitis B and C affects 328 million people globally and is nearly 10 times the magnitude of the global HIV epidemic. The epidemic caused by hepatitis B (257 million) mostly affects the WHO African Region and the Western Pacific Region. The epidemic caused by hepatitis C (71 million) affects all regions, with major differences between and within countries. The WHO Eastern Mediterranean Region, Western Pacific Region and the European Region have the highest reported prevalence of hepatitis C[1].

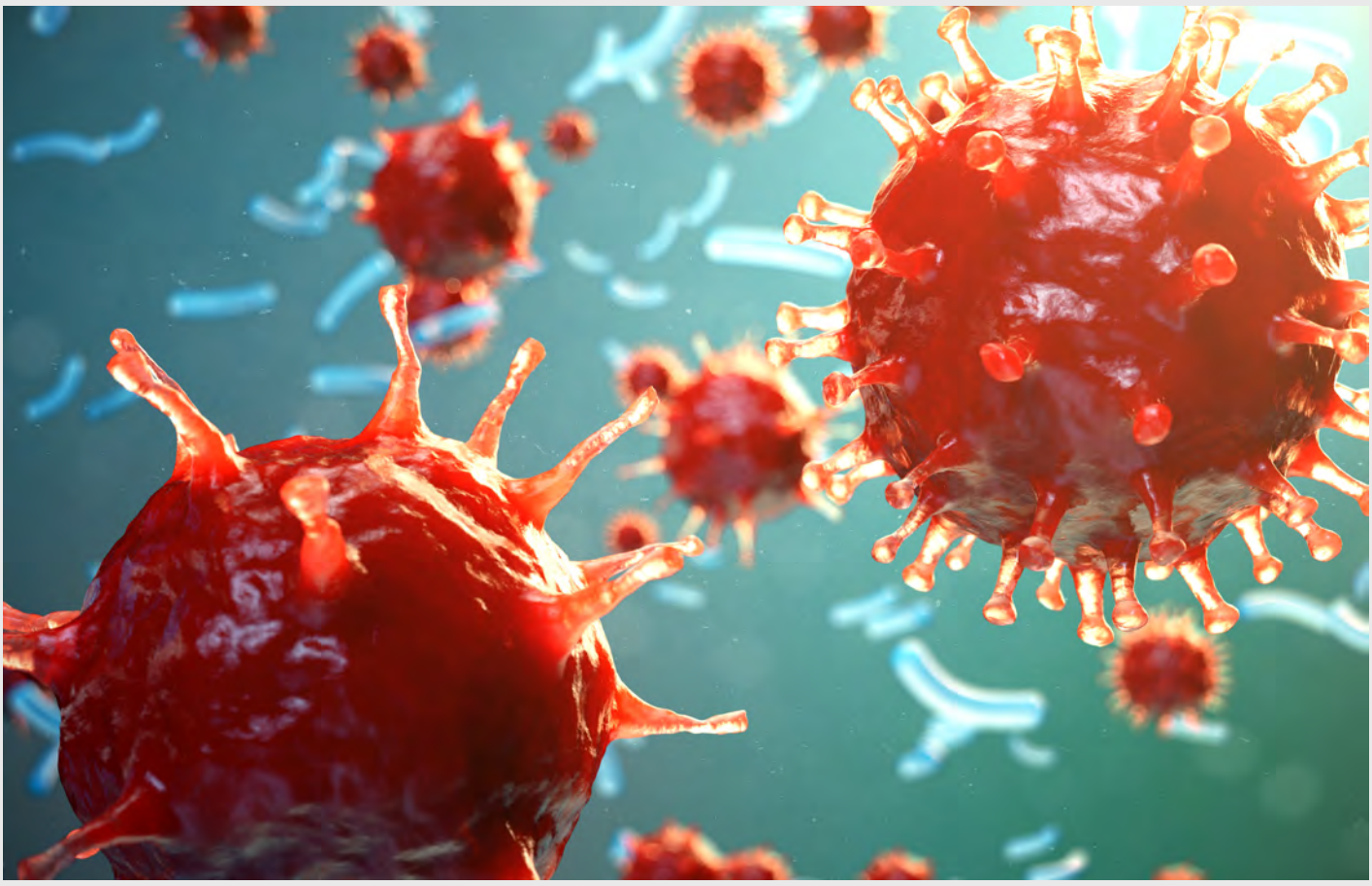
Everyday, more than 3,600 people die of viral hepatitis-related liver disease, failure and liver cancer. Data from the Global Health Estimate 2015 showed that the number of deaths from hepatitis B and C has increased by 22% from the baseline in 2000[2]. In contrast, the death rate from HIV has been rapidly declining due to universal and sustained access to care.

> "A recent study conducted by the World Hepatitis Alliance suggests that lack of awareness among the population and policymakers and even healthcare workers is a significant barrier to prevention and testing of viral hepatitis. This low level of hepatitis awareness has significant implications for ongoing transmission, especially high mother to child transmission and household transmission in children and siblings and unsafe injection practices."

In response to the growing threat of viral hepatitis, the World Health Assembly endorsed the Global Hepatitis Strategy for the elimination of viral hepatitis as a public health threat by the year 2030 with two impact targets relating to incidence (decreased incidence of new infections by 90%) and deaths (reduction in mortality by 65%)[2]. To accomplish these targets, modelling studies have identified five key interventions in prevention, testing and treatment that will reach these targets only if taken to scale.

Tell us about the distinct types of viral hepatitis (A, B, C, D, E)

Although there are mainly five distinct types of viral hepatitis (A, B, C, D, E), 96% of morbidity and mortality



are due to chronic hepatitis B and C infections. Hepatitis D occurs only in people who have hepatitis B, has a variable global and regional distribution.

Acute infection is associated with all types of viral hepatitis A-E, is often short-lived, may be associated with jaundice, low mortality rate and complete resolution within a few weeks. Hepatitis A and E are spread via contaminated food and water and cause disease outbreaks in areas of poor sanitation and inadequate waste disposal with a mortality rate as low as 0.8% in HAV and 3.5% in HEV[3]. Ensuring high levels of sanitation and access to clean water are the most effective prevention for hepatitis A and E.

Progression to chronic infection and chronic liver disease is a defining feature of both hepatitis B and C infection. Most viral hepatitis deaths in 2015 were due to chronic liver disease (720,000 deaths due to cirrhosis) and primary liver cancer (470,000 deaths due to hepatocellular carcinoma). In Africa, liver cancer occurs at a younger age, causing catastrophic expenditures and impacting negatively the economic productivity. The disease is rapidly fatal and the opportunity for surgery and transplantation is limited.

How is the virus picked up and which groups of people does it affect the most?

The epidemic of chronic viral hepatitis in sub-Saharan Africa affects over 71 million people. There is a high rate of hepatitis B infection with a general population prevalence of 6.1% with over 60 million people estimated to be chronic carriers. Chronic hepatitis B infects approximately one in every 15 people (1:15), 4.8 million are children under the age of five years and over 2 million with HIV/Hepatitis B co-infections (in 2015)[2]. The hepatitis C infection affects 10 million people with higher occurrence in older age and some key populations including PWID- Persons who inject drugs.

In Africa, hepatitis B is mostly acquired in the perinatal period (including mother to child transmission) and in childhood with 50% to 90% going on to develop a chronic infection with a high risk of liver cirrhosis or cancer over two to three decades. For these reasons, WHO recommends hepatitis B vaccination at birth (within 24 hours) and early childhood as a high impact intervention and an important prevention pillar of the global hepatitis response. In contrast, hepatitis B infection acquired in adulthood leads to the development of chronic infection in less than 5% of adults.

Unsafe injection practices both in health facilities and in the community account for the majority of hepatitis C infection in Africa, with several investigators suggesting large-scale transmission in the 1990s due to unsafe injections and blood transfusion[4,5]. Intravenous drug use is an emerging concern for hepatitis C transmission in Africa and is recognised as the most prominent route of transmission in Europe and the U.S. In Africa, one in 100 (1:100) people are infected and most may ultimately need treatment.

> "Implementing the global hepatitis response in Africa will require investments in hepatitis-specific activities and strengthening health systems, as well as ensuring the availability of adequate, sustained financial resources; affordable good quality diagnostics, medicines and Hep B birth dose vaccines; and trained human resources."

The available evidence suggests that over 1.5 million infected Africans may develop progressive liver disease in the next few decades in the absence of large-scale testing and treatment programmes for both hepatitis B and C. This is unacceptable for a disease that can be prevented with childhood vaccination and hepatitis B birth dose and effectively managed with affordable and cost-effective suppressive hepatitis B or curative hepatitis C antiviral therapy.

Despite these compelling statistics, less than 5% of infected persons in Africa know their hepatitis status[1]. This is a sharp contrast to the HIV response where approximately 80% of PLWHA are aware of their status. A recent study conducted by the World Hepatitis Alliance suggests that lack of awareness among the population and policymakers and even healthcare workers is a significant barrier to prevention and testing of viral hepatitis[6]. This low level of hepatitis awareness has significant implications for ongoing transmission, especially high mother to child transmission and household transmission in children and siblings and unsafe injection practices.

How is it treated?

Testing is the gateway to treatment. In most of the sub-Saharan countries, blood testing for viral hepatitis is not routinely provided except in blood banking services, specialist centres and in the private sector. In 2015, approximately 1.3 million people with hepatitis B infection and nearly 500,000 people with hepatitis C were detected in the blood transfusion services in Africa[7]. In the absence of counselling and linkage to care, this represents a huge missed opportunity for intervention.

All persons with chronic hepatitis B or C require further assessments. In adults, anti-viral therapy is effective and rapidly causes viral suppression in chronic hepatitis B, thus, limiting disease progression. Treatment is recommended in all patients with HIV- hepatitis B co-infection and in people with hepatitis B mono infections who have evidence of liver disease or are at a higher risk of disease progression[3]. Treatment is recommended for all hepatitis C infected persons with evidence of viremia. The development of curative direct antiviral therapy (DAA) has revolutionised treatment with cure rates exceeding 95% when treated for 12 weeks.

Identification of people with hepatitis (case finding) is a significant step in the global response and provides the opportunity for disease assessment and treatment to halt disease progression and maintain and improve the quality of life. People need to take steps to know their status and receive counselling for other co-risk factors, such as alcohol and cigarette consumption, aflatoxin ingestion and obesity that may accelerate the development of liver disease.

The priorities for tackling viral hepatitis in Africa

Although viral hepatitis has become a disease that can be eliminated, progress in scaling up the hepatitis response to prevent premature death from complications of liver cirrhosis or the development of liver cancer remains inadequate.

Implementing the global hepatitis response in Africa will require investments in hepatitis-specific activities and strengthening health systems, as well as ensuring the availability of adequate, sustained financial resources; affordable good quality diagnostics, medicines and Hep B birth dose vaccines; and trained human resources. Some of the challenges to scale up include poor political and community awareness and stigma, high cost of diagnostics and drugs and lack of surveillance data. Government leadership is critical to the establishment of a sustained public health response and has the potential to be cost-effective, reach millions of the infected populations and save lives.

> "Identification of people with hepatitis (case finding) is a significant step in the global response and provides the opportunity for disease assessment and treatment to halt disease progression and maintain and improve the quality of life."

The role of the community and patient groups cannot be understated. Globally, civil society organisations promoted by World Hepatitis Alliance have commenced a widespread testing campaign tagged "finding the missing millions". Their collaboration with civil-society groups in Africa has increasingly enhanced awareness and demand for hepatitis services. A strategy of decentralisation of care and integration of specific hepatitis activities into existing healthcare services or disease programmes such as HIV/TB appear feasible and can facilitate cross programmatic efficiencies and promote universal healthcare. Investment in healthcare financing, mobilisation of domestic financing and partnerships, community commitment are required to launch a successful and sustainable programme.

The development of affordable multi-platform laboratory tests, efficient supply chain and pooled procurements, implementation research into efficient service delivery models and other innovations may accelerate the response towards the vision of a "Region where hepatitis transmission is halted and everyone living with viral hepatitis has access to safe, affordable and effective care and treatment." ■

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Prof Olufunmilayo Lesi
Regional Medical Officer for Viral Hepatitis
The World Health Organization (WHO)
Regional Office for Africa
Tel: +47 241 39975
lesio@who.int
www.afro.who.int
www.twitter.com/WHOAFRO

Multi-step regulation of hepatitis B virus entry

Koichi Watashi, Senior Researcher from the National Institute of Infectious Diseases, Japan, explores the trick for cell invasion in reaching regulation of hepatitis B entry

Chronic hepatitis B virus (HBV) infection is estimated to affect approximately 257 million people worldwide. For achieving the World Health Organization (WHO) strategy to control hepatitis by 2030[1], understanding the HBV transmission is of particular importance. Viral transmission is determined by factors derived from both virus itself and host. One of such major factors in host is a cell surface protein that mediates the binding to virus, defined as a viral entry receptor. Sodium taurocholate cotransporting polypeptide (NTCP), a bile acid transporter, has been revealed to function as an HBV entry receptor in 2012[2]. This protein, expressed exclusively in the liver, is an apparent factor determining the HBV infectivity to host.

However, it has been totally unclarified how NTCP mediates HBV entry and determines host susceptibility to HBV infection. In April 2019, Koichi Watashi's group in National Institute of Infectious Diseases, Japan published a paper in Proc Natl Acad Sci USA that provides a new concept that HBV infection is determined by another molecule that regulates the function of virus-receptor complex, termed as an entry cofactor[3].

Cell culture and animal model data so far demonstrate that NTCP is required for HBV infection. However, there is accumulating evidences suggesting that NTCP expression is not sufficient for reproducing HBV infection in cells: HBV infection is not necessarily observed in all the NTCP expressing cells, and the infection in susceptible cells depends on culture condition, irrespective of the NTCP expression level. This data raises the possibility that another factor(s) regulates HBV infection. Koichi Watashi's group has been pursuing to identify a series of small molecules and bioactive ligands that suppress or facilitate hepatitis virus infection. Their strategy is to take advantage of these agents to probe the mechanisms underlying virus infection.

So far, they have identified a bunch of small molecules that inhibit HBV infection, including cyclosporins, tricyclic polyketides, synthetic retinoids, coumarines, macrolides, thiazolidinediones, and cyclic peptides, which were reported in the context of drug development[4]. In addition, the group has also found those rather facilitating HBV infection, one of which is epidermal growth factor (EGF). By focusing on this probe, they revealed that EGF receptor (EGFR) regulates HBV infection to NTCP-expressing cells. Even if expressing NTCP, HBV infection was no more observed by deficiency of expression or function of EGFR.

Mechanistically, while NTCP mediates HBV attachment to the cell surface, EGFR was shown to be involved in HBV translocation to the endosomes (Figure). Their data and previous evidences suggest that EGFR interacts with NTCP irrespective of HBV infection: EGFR-NTCP complex is likely to travel between the cell surface and the intracellular vesicles by following the cellular membrane trafficking pathway either in the presence or absence of infection. When HBV attaches to NTCP on the cell surface, it migrates with NTCP-EGFR inside the vesicles through the trafficking. Thus, NTCP functions for the attachment with HBV, and EGFR drives the internalization of HBV-NTCP complex.

> "Taking advantage of small molecules/bioactive ligands to probe the mechanisms underlying virus infection."

Notably, if NTCP does not bind to EGFR, NTCP no longer functions as the entry receptor of HBV, which was shown by the blockade of NTCP-EGFR binding by introducing amino acid mutation and treatment with decoy peptide. This data clearly show that productive infection of HBV requires EGFR as an entry cofactor, in addition to NTCP.

Human immunodeficiency virus (HIV) uses its receptor, CD4, for cell attachment and requires another involvement of coreceptor, CCR5 or CXCR4 for the following membrane fusion. Hepatitis C virus (HCV) attaches to host cells through CD81 and scavenger receptor class B type I (SR-BI), which then clusters with tight junction

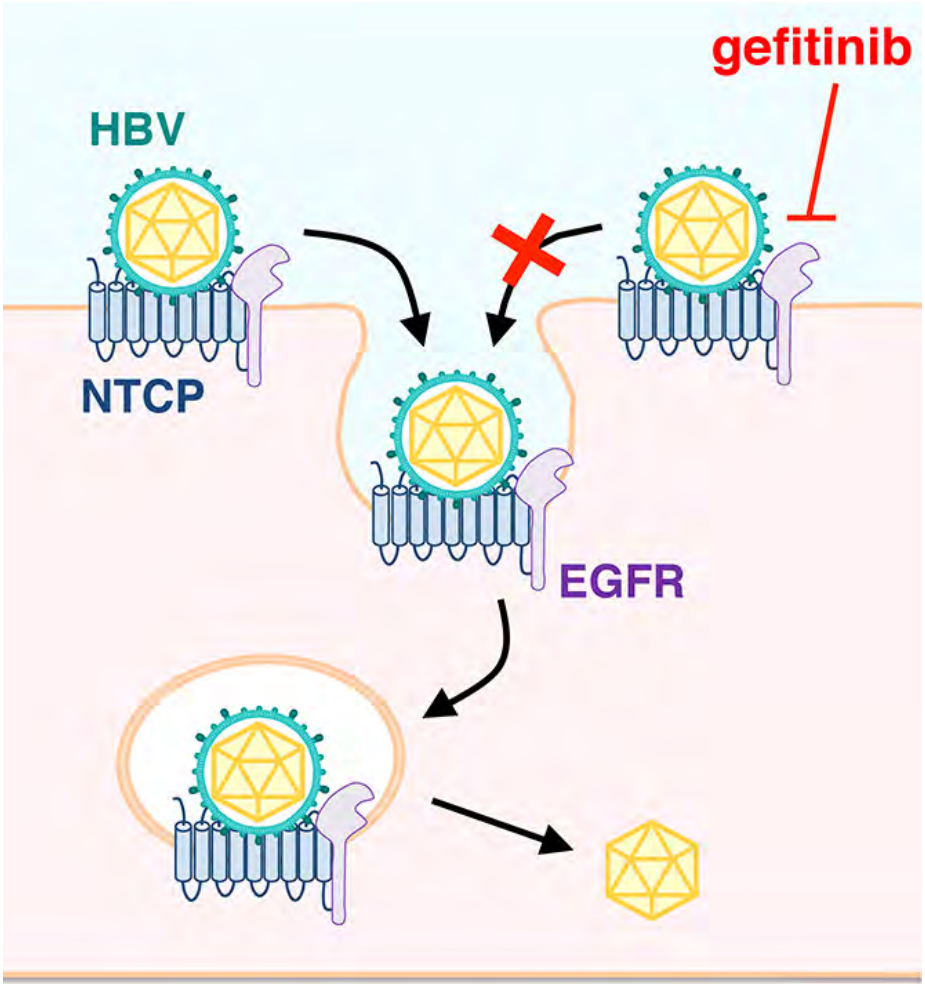

Figure 1. HBV entry. After HBV binds to its receptor, NTCP, HBV-NTCP-EGFR complex is internalised into cells. Gefitinib blocks HBV internalisation through inactivation of EGFR

proteins, claudin-1 and occludin for internalization. The presenting multi-step regulation of HBV entry is analogous to such examples for the entry mechanism of these viruses. However, it is unique that HBV follows the cellular intrinsic pathway of the membrane protein trafficking that readily occurs in the absence of infection.

Moreover, as EGFR senses extracellular ligands to change its functionality, HBV susceptibility of cells may be affected by these extracellular ligands, not only by NTCP genetic condition. Next questions include whether only EGFR functions as an entry cofactor of HBV, given that cells express related receptor tyrosine kinases such as fibroblast growth factors, vascular endothelial growth factors, and platelet-derived growth factors. How the entry cofactor drives HBV internalization, and releases HBV afterwards for the productive viral infection? Good news is that this machinery is expected to serve as a target for anti-HBV development. Actually, a peptide that interrupted EGFR-NTCP binding blocked HBV internalization and infection.

Similarly, EGFR tyrosine kinase inhibitor, gefitinib, a clinically used anti-cancer drug, inhibited HBV infection. Further analysis of targeting this machinery for developing a new anti-HBV strategy is of great demand in the near future. Albeit still many blackbox, we have had a significant gain of understanding in this decade on the mechanism underlying HBV infection and determining the susceptibility to HBV. Further analysis on HBV infection is expected to develop new strategies to control the worldwide hepatitis.

> "EGFR entry cofactor function is expected to serve as a target for anti-HBV development."

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Koichi Watashi
Senior Researcher
National Institute of Infectious Diseases, Japan
Tel: +81 352 851 111
kwatashi@nih.go.jp
www.niid.go.jp/niid/en/vir2-e.html

Paediatric Hepatitis B: Investigating fingernails and hair

Hepatitis B virus (HBV) infection is one of the main things which can lead to liver cirrhosis and hepatocellular carcinoma

Hepatitis B virus (HBV) infection is one of the main things which can lead to liver cirrhosis and hepatocellular carcinoma. The contact with blood and body fluids from patients with HBV can transmit the infection to other people. According to the World Health Organization (WHO), an estimated 257 million people are globally living with HBV infection. The mortality from Tuberculosis, human immunodeficiency virus and Malaria show a downward trend during 2000 and 2015, whereas the mortality from viral hepatis including hepatitis C is increased during the same period. The number of deaths rose from 1.10 million deaths in 2000 to 1.34 million deaths in 2015 (an increase of 22%), which is on par with tuberculosis. The WHO calls for the elimination of viral hepatitis as a public health threat by 2030 (reducing new infections by 90% and mortality by 65%).

Nails and hair are used as they reflect metabolic events that occur during the short time of their formation, and have the advantage of painless collection, easy transportation, and reliable storage at room temperature.

HBV vaccination, prevention mother-to-child transmission, blood safety, injection safety, harm reduction, diagnosis and treatment are the key elements for the elimination strategy of HBV infection. Innovation is required to eliminate HBV. New diagnostics and treatments need to be developed. Only 9% of persons living with HBV (22 million) had been tested and knew their status. Therefore, the promoting to uptake of hepatitis testing is extremely important to introduce treatment. In the medical resources constrained countries and regions, however, the access to medical institutions and hospitals is limited. Lack of access to appropriate healthcare service affects severely the prognosis of infected children.

To remove the barrier of access to hepatitis testing, we focus on nails and hair to develop new diagnostic method. Usually, blood is used for the diagnosis of HBV infection. Nails and hair, which are so-called "keratinous tissue," have the advantage of painless collection, easy transportation, and reliable storage at room temperature. Nails and hairs are formed within a relatively short time and then isolated from the body, which continues its metabolic activities. The components of nails and hair thus reflect metabolic events that occur during the short time of their formation, and nails and hair have been evaluated in clinical practices (e.g., for the measurement of trace elements). A previous study demonstrated that the assessment of glycated nail proteins is useful for the diagnosis of diabetes. Screening for diabetes with the use of nails could be helpful in resource-constrained counties. In addition to trace element and proteins, nails and hair have been used for the investigation of nucleic acid. The amount of DNA in nails and hair is much smaller than that in other

Haruki Komatsu, Medical Doctor, Associate Professor, M.D., Ph.D.

tissues such as liver, muscle and blood. However, nails and hair contain sufficient amounts of DNA including mitochondria DNA for analysis. Archaeology and forensic science studies have used nails and hair for DNA analyses over the past two decades.

We investigated nails and hear from the patients infected with HBV. Nails and hairs have signatures of chronic HBV infection. HBV DNA was detected in nails and hear from approximately 80% to 90% of patients with chronic HBV infection. Moreover, hepatitis B surface protein can be extracted from the nails. Histopathology shows that hepatitis B surface protein is present in the nails. In addition to HBV, hepatitis delta virus (HDV) is evaluated in our lab. HBV carriers could be co-infected or superinfected with hepatitis delta virus. HDV is a defective RNA virus which requires the surface antigen of HBV for viral assembly and replication. We also detected HDV protein and HDV RNA in nails from patients co-infected with HBV and HDV. Nails and hairs have a potential as diagnostic tools in the infectious diseases. For instance, cytomegalovirus (CMV), which is a common virus and infects people of all ages, can be detected in the nails. Congenital CMV infection can be diagnosed using nails of neonates. Other DNA and RNA viruses might be detected in nails and hairs.

The research of nails and hairs has just begun in this infectious disease. In the future, nails and hair might be able to become useful specimen comparable to blood in infectious diseases. We hope that our research will contribute to the clearance of hurdle to take diagnostic examination of HBV infection in resources-constrained counties. The final goal of our research is the eradication of HBV infection.

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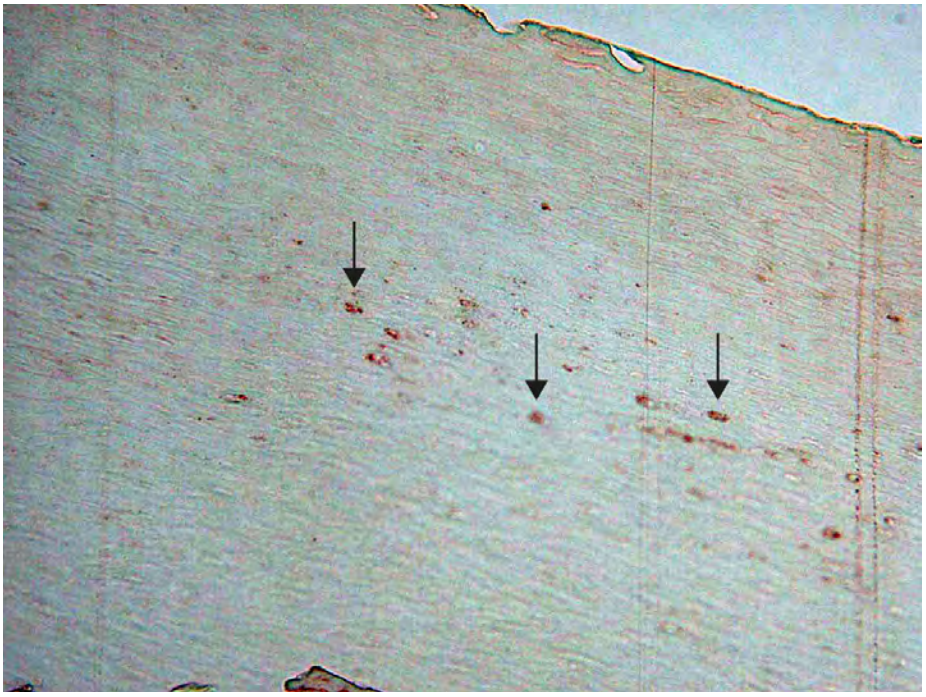

Nails, HBsAg (Immunochemical staining)

Haruki Komatsu
Medical Doctor, Associate Professor, M.D., Ph.D.
Toho University Sakura Medical Center
Tel: 81-43-462-8811
Haruki-komatsu@chive.ocn.ne.jp
www.lab.toho-u.ac.jp/med/sakura/ped/index.html

Cardiovascular diseases - how to prevent them

Cardiovascular diseases are on the rise, but so is confusion as to how to prevent them. Shaun Ingram, MD of Cardiac Science takes a look at the data, shares his views and strikes a cautious note of optimism

At first glance, the stats are disheartening. Cardiovascular diseases (CVD) are the number one health issue affecting people worldwide, with more people dying each year from them than from any other cause. An estimated 17.9 million people died from CVDs in 2016, representing 31% of all global deaths. Of these deaths, 85% were due to strokes or heart attacks.

Despite the overwhelming figures, the truth is they only hint at the scale of the issue. Death rates don't account for the millions around the world living with a CVD that requires long-term treatment. In the UK alone, there's an estimated 7.4 million people living with heart and circulatory diseases. Given the size of the issue the notion of a 'cure' might seem hopeless to contemplate, but most CVDs can actually be prevented by addressing behavioural and lifestyle factors.

But first, what actually are CVDs?

Cardiovascular diseases are disorders that affect the heart and blood vessels. Common conditions include coronary heart disease, congenital heart disease and deep vein thrombosis. Heart attacks and strokes are generally acute events, brought on by a build-up of fatty deposits in the blood vessels blocking blood flow to the heart or brain.

Who's at risk?

Though the clear cause of CVD isn't clear, there are many factors that increase your likelihood of getting one. High blood pressure, smoking, high cholesterol and obesity are all high risk factors for CVDs. Other factors can also come into play, such as age, gender and family history. Anyone can get a CVD but they're most common in people over 50. Additionally, they typically affect more men than women, with 3.9 million men in the UK living with a CVD compared to 3.5 million women.

What can I do?

'Prevention is better than cure' is a proverb often used in cardiovascular medicine, because it's much easier to implement lifestyle changes early than to readjust to the difficult reality of living with CVD. Taking steps toward a healthier lifestyle is one of the most effective ways to reduce your chances of CVD. Cutting out unnecessarily toxic habits dramatically reduces your risk of CVD. If you smoke or drink excessively you should try to give up or drastically reduce your intake as soon as possible.

> "The World Heart and Stroke Forum recommends that every country should have an up-to-date policy on CVD prevention. This should be developed through ongoing dialogue between governmental, social and health groups, with three major strategic angles: population strategy, high risk strategy and secondary prevention."

When it comes to diet, establishing a healthy balance is recommended to lower your blood pressure and cholesterol levels. Eating more fruit and vegetables and lowering your intake of saturated fats, sugar and salt can go a long way to guaranteeing you a longer and healthier life.

CVDs can affect anyone, regardless of your fitness level. However alongside dietary changes, it's important to establish a regular exercise regime. Adults are recommended to do at least 150 minutes of moderate physical activity a week. Obviously, the difficulty level can be adjusted depending on your fitness level and you can consult your GP for recommendations.

According to PHE's Health Profile for England, falling mortality rates from heart disease were the biggest cause of increases in life expectancy between 2001 and 2016. Since then, these rates have slowed significantly,


Shaun Ingram

signalling the need for a renewed effort to prioritise CVD prevention on a policy level.

What can the government do?

The World Heart and Stroke Forum recommends that every country should have an up-to-date policy on CVD prevention. This should be developed through ongoing dialogue between governmental, social and health groups, with three major strategic angles: population strategy, high risk strategy and secondary prevention.

Population strategy is about tackling the lifestyle and environmental factors that can cause CVD to develop. High risk strategy is about identifying and treating high risk individuals early, through things like better screening and earlier diagnosis. Finally, secondary prevention is about stopping the progression of the disease in people who have already been diagnosed.

So what does this mean in practice? Between 2001 and 2016, the policies that made a big difference were actions such as banning smoking in public places, improving population-wide blood pressure levels and introducing better treatments through advances in medical science. But what to try next all depends on the country and culture in question.

For instance, while lack of nutrition is one of the biggest CVD risk factors in developing countries, in developed countries where many people drive around, it's lack of physical activity. Developed countries aren't all the same either: alcohol is a huge risk factor in European countries, but much less so in other nations like UAE and Saudi Arabia, where alcohol use is much more controlled.

Clearly, there is no one size fits all approach. It is up to each individual government to develop policies that address key CVD risk factors in their country, in a way that works economically.

So, whose responsibility is it?

According to the World Health Organization (WHO) tackling CVD is everybody's responsibility. And the only way to beat it is through a combination of population-wide and individual healthcare strategies. However, at Cardiac Science my team and I believe there are two other factors that make a big difference: awareness and accessibility.

That's why we constantly strive to raise awareness of the risk factors for CVD, the conditions that can lead to cardiac arrest and the steps you can take to protect yourself and others.

And although we can't provide global access to healthy food and exercise, we are constantly researching the latest defibrillator technology and placing public-access defibrillators far and wide. Ultimately, with the hope of saving more lives.

To find out more about life-saving skills and CVD, click here. ■

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Shaun Ingram, MD
Cardiac Science
Tel: +44 (0)161 926 0000
sales@cardiacscience.co.uk
http://cardiacscience.co.uk/
www.twitter.com/Cardiac_Science

Gemelli

Fondazione Policlinico Universitario A. Gemelli
Università Cattolica del Sacro Cuore

New evidences on the role o in Acute coronary syndrom

Prof Luigi M Biasucci, Fondazione Policlinico A Gemelli, and Catholic University of Rome, Italy

For a long time the causes of acute coronary syndromes were poorly understood, and, only after the publication of our paper on New England Journal of Medicine on the importance of inflammation (The prognostic value of C-reactive protein and serum amyloid a protein in severe unstable angina).

Liuzzo G, Biasucci LM, Gallimore JR, Grillo RL, Rebuzzi AG, Pepys MB, Maseri A.N Engl J Med. 1994 Aug 18;331(7):417-24.) it was recognized as a crucial pathogenetic mechanism. Along time, more evidences reinforced this hypothesis that is gaining an increasing interest in research and in clinical practise. The several studies published in the last years have confirmed and expanded the previous data and opened to novel finding. In particular, the role of Citokines, first discovered by our group and subsequently reported by Paul Ridker in Boston with more evidences, paved the way in the Cantos study, to the anti-Citokines therapy. Although efficient this therapy is expensive and may carry a risck of infection.

More recently, novel findings raised the evidence that NL3P3 inflammosoma, that may induce further inflammation, in particular increasing levels IL-18 and IL-6, may increase the cardiovascular risk. As the balance between reduction and increase in this field is small, in similar conditions the risk of infarction is elevated, and may be responsible of death. For this reason correction of inflammation is an important issue in cardiovascular diseases and its control may significantly reduce mortality.

f inflammation
es and its pathogenesis

However treatment based on cytokines is expensive and may carries further problem. Therefore, other treatments may be requested in order to reduce the residual risk. These treatments may include anti-inflammatory cytokines, but also the possibility of better controlled further risk factors, including microbioma. Novel but extremely important risk factors, linked to mortality and to intestinal (but not only) diseases and deriving from more than 3 trillion bacteria. Several studies have already stressed this pathway and there is an increasing interest in the field. Indeed, the inflammatory hypothesis could by linked with the Gut Microbioma that, in several condition, and thanks to its enormous amount of bacteria, may overcame the body defences and bring to overt disease.

These findings, if further confirmed, may open new and revolutionary treatments in the prevention and therapy of Acute Coronary syndromes.

Luigi Marzio Biasucci MD
Associate Professor of Cardiology
Fondazione Policlinico Universitario A Gemelli
Department of Cardiovascular and Thoracic Science
luigimarzio.biasucci@unicatt.it
http://docenti.unicatt.it/web/didattica.do?cod_docente=46359&language=ITA&section=didattica

The cardiovascular disease burden from ambient air pollution in Europe

Thomas Münzel MD, Andreas Daiber PhD, Ulrich Pöschl PhD and Jos Lelieveld PhD
discuss the link between air pollution and cardiovascular disease in Europe

By way of an introduction, ambient and household air (indoor air) pollution are considered to be major health risk factors leading to morbidity and premature mortality with significant direct and indirect costs to the community[1]. The World Health Organization (WHO)[2] and the Global Burden of Disease (GBD) project[1] calculated for 2015, 4.2 million premature deaths per year worldwide due to air pollution especially by particulate matter with an aerodynamic diameter < 2.5 µm ($PM_{2.5}$). More than half of the deaths were the result of cardiovascular diseases such as coronary heart disease and cerebrovascular disease due to embolic and hemorrhagic stroke but also due to other non-communicable diseases such as arterial hypertension, diabetes, lung cancer and chronic obstructive pulmonary disease.

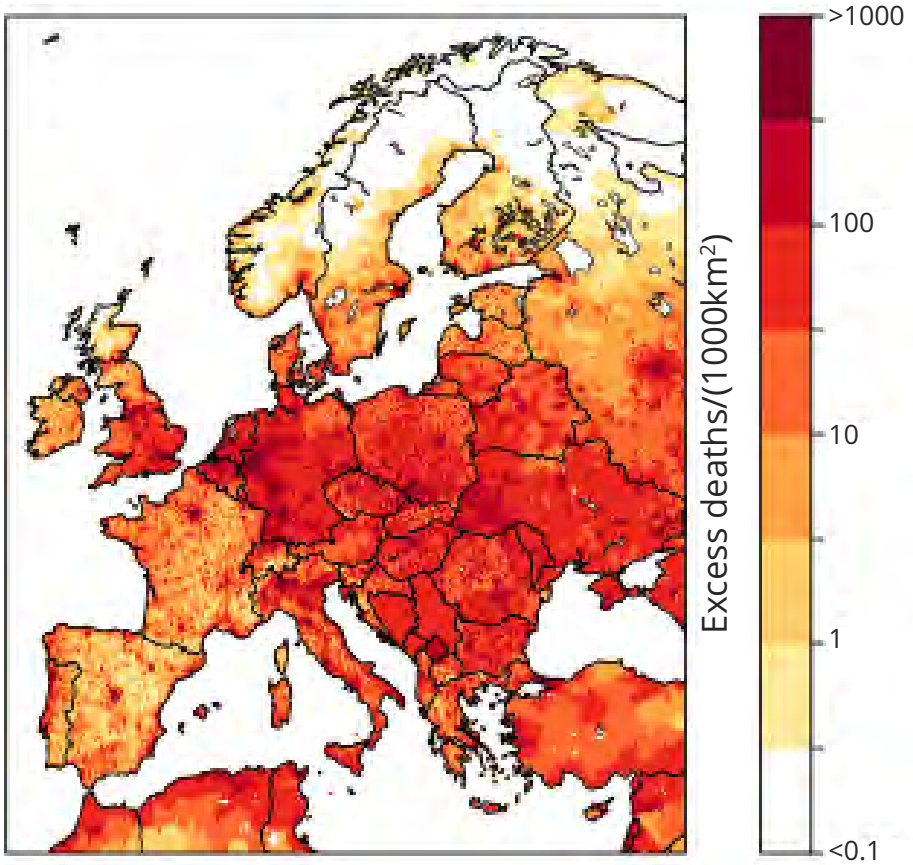

Figure 1. Regional distribution of estimated annual excess mortality rates from cardiovascular diseases (CVD = IHD (ischemic heart disease) + CEV (cerebrovascular disease) attributed to air pollution. These rates are lower limits as other non-communicable diseases are not included

Death rates due to air pollution are significantly higher than previously thought

In 2018 and 2019, two new studies calculated a much higher mortality and morbidity burden than previously thought, in particular due to the use of a new and much more accurate hazard ratio function of the $PM_{2.5}$ concentration-response association, the GEMM.[3,4] This model has a number of advantages over the Integrated Exposure-Response Function (IER) formerly used by the WHO and GBD and is now considered by both WHO and GBD to calculate premature mortality. Richard Burnett's GEMM is based on the analysis of much larger and geographically extended epidemiological data obtained from 41 cohort studies from 16 countries.[3] This implies the inclusion of an additional 20 000 cases and 2.5 million deaths from study data from heavily polluted and densely populated countries such as China, whereas the WHO-GBD-IER mainly covered data from less polluted western regions such as Europe, Canada and the U.S.

In addition, IER mortality has been reported to be based on five major causes including coronary heart disease, cerebrovascular disease, chronic obstructive pulmonary disease, lung cancer and lower respiratory tract disorders, while in the study by Burnett et al.[3] the development and application of GEMM was based on

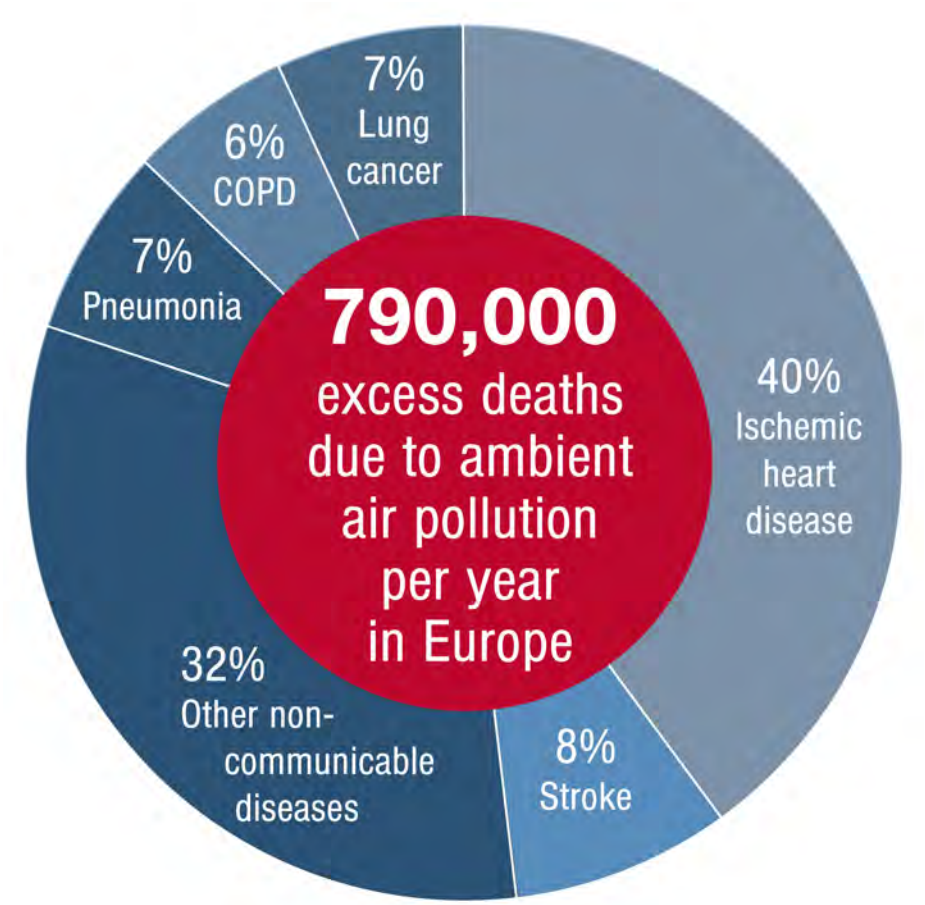

Figure 2. Estimated excess mortality attributed to air pollution in Europe and the contributing disease categories. At least 48% are due to cardiovascular disease (ischaemic heart disease and stroke). A fraction of other non-communicable diseases should also be counted to cardiovascular diseases related mortality, with an upper limit of 32%. COPD, chronic obstructive pulmonary disease

Image: © 2019, Oxford University Press

worldwide mortality data from all non-communicable diseases as well as pneumonia. The estimated additional air pollution death rate was 8.9 million, more than twice that of the GBD and WHO (4.2 million).

Recently, Lelieveld et al.[4] calculated that, based on the GEMM for Europe, this would result in up to 790,000 premature deaths per year mostly due to $PM_{2.5}$ exposure, more than twice based on the previous GBD-IER estimate (269,000) (Figures 1 and 2). Interestingly, the highest numbers of premature deaths occurred in Germany (154 per 100,000 per year), followed by Poland (150), Italy (136), France (105) and the United Kingdom (98)[4] (Table 1). The main part of the mortality was due to cardiovascular diseases. As estimated by Jos Lelieveld et al. , $PM_{2.5}$ air pollution reduces the European average life expectancy by 2.2 years.[4] To put this into perspective, the WHO estimates that the excess death rate from tobacco smoking is 7.2 million per year; hence, air pollution globally is now rated as the larger risk factor.

Effects of air pollution on the cardiovascular system

When discussing the pathophysiological effects of air pollution, we focus on $PM_{2.5}$ because, in particular, the small particulate matter particles can penetrate deeply into the lungs. Following inhalation of $PM_{2.5}$, the fine aerosol particles are released into the bloodstream via a transition process and then absorbed into the blood vessel.[5-7] The particulate matter in the vessel wall stimulates the formation of reactive oxygen species, i.e., pro-oxidative substances and pro-inflammatory biological mediators (i.e., such cytokines as interleukin-6 and tumor necrosis factor) and acute phase proteins such as the C-reactive protein and the vasoconstrictor hormone endothelin.[5-7] These processes initiate or accelerate atherosclerotic changes. In general, the smaller the particle is (down to ultrafine particles <0.1µm, $PM_{0.1}$), the higher the probability of a rapid translocation of the particles into the vessel wall.[7]

Furthermore, activation of blood coagulation is observed. Accordingly, high levels of $PM_{2.5}$ are accompanied by hypercoagulation biomarkers, such as high plasma levels of fibrinogen and D-dimer and increased thrombin formation.[5-7] Human data show an inverse relationship between PM exposure and heart rate variability.[5-7] $PM_{2.5}$ can induce arterial hypertension via direct sympathetic activating effects in the brain[6,7] or by triggering endothelial dysfunction due to decreased vascular nitric oxide (NO) bioavailability.[7]

The particulate matter limits for Europe are too high

In view of the WHO recommended guideline of 10 µg m^3 for $PM_{2.5}$, it can be assumed that more than 91% are exposed to higher concentrations worldwide. The European Union (EU) has been applying a mean air quality limit of 25 µg/m^3 for $PM_{2.5}$ since 2015, which is 2.5 times higher than the WHO guideline of 10 µg/m^3. The

Table 1. Estimated annual excess mortality attributed to air pollution*

	All risks	From air pollution#							
	Total CVD mortality ($x10^3$)	CEV ($x10^3$)	IHD ($x10^3$)	CVD† ($x10^3$)	other NCD† ($x10^3$)	All diseases‡ ($x10^3$)	Deaths per 100,000	YLL ($x10^6$)	LLE (years)
Europe	2,138	64	313	377 (48%)	255 (32%)	790	133	14	2.2
EU-28	1,849	48	216	264 (40%)	249 (38%)	659	129	11.5	2.1
Germany	330	7	42	49 (40%)	48 (39%)	124	154	2.1	2.4
Italy	221	6	23	29 (36%)	35 (43%)	81	136	1.2	1.9
Poland	180	6	27	33 (57%)	13 (22%)	58	150	1.1	2.8
United Kingdom	147	3	14	17 (27%)	29 (45%)	64	98	1.1	1.5
France	144	3	13	16 (24%)	38 (57%)	67	105	1.1	1.6

** Data for all EU countries, including 95%CI, are given in the supplement (overall uncertainty about ±50%).*

 # CEV is cerebrovascular disease, IHD is ischaemic heart disease, CVD are total cardiovascular diseases (CEV+IHD), NCD are non-communicable diseases. YLL are years of life lost. LLE is loss of life expectancy.

† Percentages refer to fractional contributions of CVD and other NCD to attributable mortality from all diseases.

‡ All diseases refer to NCD+LRI

target is 20µg/m³ by 2020, which is considered too high as well due to the new data. For comparison, the annual average limit in the US is 12 µg/m³ (since 2012) and in Canada 10 µg/m³ (since 2015), which are to be further reduced in the future. In Australia, the annual $PM_{2.5}$ limit is 8 µg/m³, which should be further reduced to 7 µg/m³ by 2025.

Key points:

- Due to air pollution ($PM_{2.5}$ and ozone), there are 8.9 million deaths per year worldwide.
- Almost 800,000 premature deaths per year are calculated in Europe, with coronary heart disease and stroke predominating, especially with around 50% of premature deaths.
- The number of deaths from particulate matter worldwide exceeds the number of deaths caused by smoking.
- The limit for Europe must, therefore, be drastically reduced
- Air pollution must be recognised as a cardiovascular risk factor and be mentioned in the guidelines of the European Society of Cardiology for Prevention, Heart Attack and Stroke and evaluated accordingly.

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Professor Thomas Münzel
University Medical Center of the Johannes Gutenberg-University Mainz
Department of Cardiology
Tel: +49 613 117 7250
tmuenzel@uni-mainz.de

Professor Jos Lelieveld
Max Planck Institute for Chemistry,
Johannes Gutenberg University Mainz
jos.lelieveld@mpic.de

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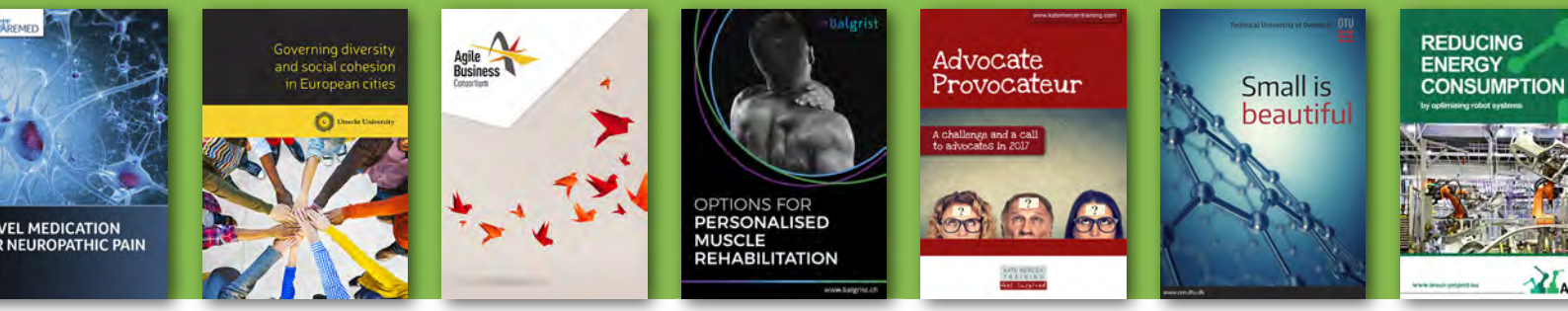

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Why we need to talk more about hearing loss

Mark Hopkinson, Head of the Centre for Deaf Education, City Lit states why we need to talk more about hearing loss

One in six people in the UK[1] has some form of hearing loss which ranges on a spectrum from profound deafness to mild hearing loss. The strategies which individuals with hearing loss use to communicate effectively vary hugely. British Sign Language (BSL), lipreading, hearing aids, cochlear implants or a combination of strategies can be used to ensure those with hearing loss can understand and be understood.

We are encouraging debate around understanding and knowledge of hearing loss and acknowledgement of how it can unnecessarily exclude people from activities which many would consider a fundamental right. Activities such as accessing healthcare at a time and place which is convenient for them or carrying out their civic duty by serving on a Jury in a crown court. Research conducted by the NHS[2] has shown that almost three-quarters of deaf people (74%) felt that their employment opportunities were limited because of their deafness and over two thirds (68%) have felt isolated at work. A lack of education and access to training is helping to keep barriers to communication in place.

Our research has revealed that:

- 94% of people surveyed don't know more than two signs in BSL.

- 60% of people would like to learn to communicate better with deaf people and those with hearing loss, which is positive news we need to build upon.

- 61% of people feel that those who are deaf, or who have some level of hearing loss, are marginalised in society because not enough people know how to communicate with them effectively. They are right. We can change this.

BSL, lipreading and managing hearing loss courses provide students with an incredible range of tools they can use in both their professional and personal lives. Further, deaf awareness training for friends and family members and organisations is important in improving communication with deaf and hard of hearing people.

"Lipreading is proven to be successful for those who seek support if they lose their hearing as adults and we believe that everyone who seeks help for hearing loss should receive advice on lipreading from their GP or Hospital. Unfortunately, there are too few classes across the UK and access is a postcode lottery."

We strive to influence the UK Government and policymakers about the importance of BSL education and we welcomed the then Secretary of State for Education, Damian Hinds MP's, announcement in November 2018 that the Department for Education and Ofqual were in the process of reviewing proposals for a BSL GCSE. Equally, we have welcomed the London Mayor's commitment to fully fund BSL Level 1 and 2 for deaf adults through the adult education budget.

Access to a BSL GCSE and increased funding are incredibly important steps in the right direction. BSL courses encourage more people to learn and perfect this much-needed skill. This includes those who use BSL as their first language or those who are fluent in English and wish to learn BSL, as well as hundreds of deaf migrants who move to London every year and require specialist tuition. City Lit knows that BSL Teacher Training is vital if the demand for learning is to be met.

However, BSL is not the only strategy for communication for those with hearing loss.

Lipreading is proven to be successful for those who seek support if they lose their hearing as adults and we believe that everyone who seeks help for hearing loss should receive advice on lipreading from their GP or Hospital. Unfortunately, there are too few classes across the UK and access is a postcode lottery. City Lit's #HearMyLips campaign goal is to train more teachers to teach more classes nationwide. ■

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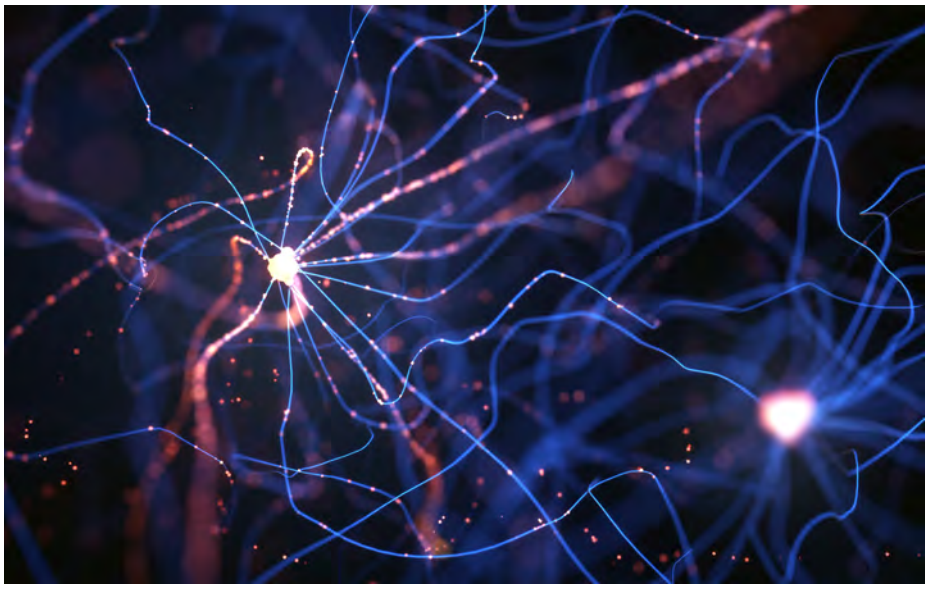
Mark Hopkinson
Head of the Centre for Deaf Education
City Lit
Tel: +44 (0)20 7831 7831
advice@citylit.ac.uk
www.citylit.ac.uk
www.twitter.com/citylit
#HearMyLips

The importance of patterned activity in the nervous system for auditory functions

George Ordiway, a PhD student in the laboratory of Dr. Jason Tait Sanchez at Northwestern University, discusses how patterned activity in the nervous system permits a wide range of biologically relevant functions, including auditory development

Our thoughts, memories, movements and sensory experiences are the result of electrical activity generated in the brain. Billions of cells make up the brain. These cells, called neurons, communicate with each other by sending electrical signals known as action potentials. Action potential properties are controlled in part by specialised membrane proteins called ion channels, of which there are numerous types. Ion channel expression is incredibly complex, and varies throughout the brain, so neurons are often classified by their functional phenotype, i.e., the pattern of their action potential firing. In this research profile, we briefly consider action potential firing patterns and the functions they serve in both normal and diseased states. We then focus on specialised firing patterns of auditory neurons and their role in hearing.



Diversity of action potential firing patterns

Since the brain is responsible for encoding all sensations and planned body movements, a vast diversity of firing patterns exists. Neurons specialised for hearing act differently than neurons for vision, but even within one sensory modality, variety in firing patterns are ubiquitous[1]. Ion channels being composed of various multiple subunits is one reason for such diversity. For example, the potassium ion channel has more than 100 subunits[2]. This is multiplied by the fact that ion channels can be regulated by molecules like glutamate[3], dopamine[4], nitrous oxide[5], cyclic AMP[6], and neural growth factors called neurotrophins[7], [See Open Access Government January 2019 and April 2019]. While this article will focus on firing patterns in the auditory system, firing patterns in the motor system also play a critical role in biologically relevant functions.

Action potential firing patterns in the motor system

Motor patterns are ubiquitous, from the rhythmic beating of the heart to the flapping of a bird's wings. Such movements are possible because of the action potential firing patterns of neurons and muscle cells. This patterned activity can be thought of as oscillations[8]. Oscillation patterns are also seen in spontaneous neuronal activity, a good example being Parkinson's disease. Parkinson's is characterised by uncontrollable and spontaneous movement tremors. Recordings of Parkinson's tremors in monkeys found oscillations at 3-19 cycles per second (Hz).

Remarkably, this oscillating firing pattern is also observed at the individual neuronal level in Parkinsons[9], which is critical to its diagonosis and treatment. However, patterned activity in Parkinson's may be the exception that proves the rule: Patterned activity is usually beneficial – if not necessary – for normal development and brain activity. This is especially true in developing sensory systems like vision and

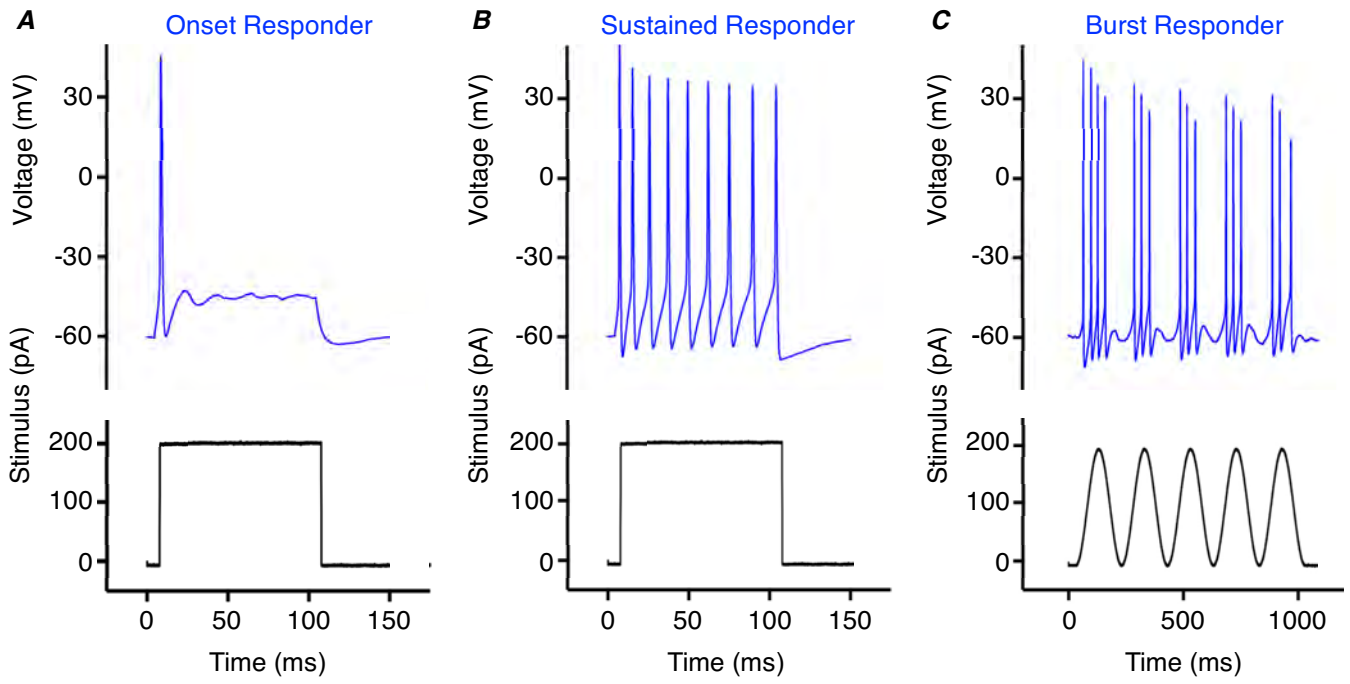


Figure 1. Action potential firing patterns in the chicken auditory brain

hearing. With vision, patterned activity is needed for eye specific segregation[10]. Auditory development is also dependent on patterned activity.

Action potential firing patterns in the developing auditory system

An exemplar of auditory development includes research in animal models like mammals and birds. Mice are born deaf, but their auditory pathways are wired to function when the onset of hearing begins. This brings up an intriguing question; how does auditory neural circuitry develop without sensory stimulation? The answer is spontaneous, patterned activity.

For example, supporting cells release ATP to activate hair cells in the cochlea, which leads to bursts of firing activity in auditory spiral ganglion neurons[11, 12]. This pattern of spontaneous activity, transmitted to the central auditory structures, changes across development. Firing patterns are random at first, gradually change to rhythmic bursts, and then show periods of higher frequency firing, corresponding to before, during and after the onset of hearing, respectively[13]. Once the auditory system is functionally mature, firing patterns are crucial to encoding different aspects of sound like frequency, intensity and temporal information found in complex signals like speech. Diverse firing patterns are observed in every region of the auditory pathway.

For example, in the cochlear nucleus – a lower auditory brainstem structure in both mammals and birds– as many as six different firing patterns have been well documented and studied with respect to different auditory functions[1, 14, 15]. Cochlear nucleus neurons receive input from one ear, but their target output neurons are located on both sides of the brainstem. These outputs are responsible for our ability to hear sound from both sides of the head on the order of tens of microseconds; a remarkable biological feat responsible for sound localisation and discriminating complex sounds in background noise[16].

Thus, cochlear nucleus neurons are critical for encoding frequency, amplitude and timing aspects of sound. In part, this is due to the firing pattern of action potentials at the onset of a stimulus (onset responders, Fig. 1A), throughout the stimulus (sustained responders, Fig. 1B), or rapid brief periods during the stimulus (burst responders, Fig 1C). Neurons with different firing patterns send outputs to many different auditory regions, critical in processing the numerous features of complex sounds.

One example come from the chicken nucleus magnocellularis – an analogous auditory structure to the mammalian cochlear nucleus. We recently reported the firing pattern from a

newly discovered region responsible for processing different frequency elements of sound. These neurons, referred to as NMc, are in stark contrast with other regions where neurons fire a single, precisely timed, onset action potential to stimulation (Fig. 1A). NMc neurons fire multiple bursts of action potentials to slow and gradual stimulation and are hypothesised to respond to ultra-low sound frequencies as low as 2Hz (Fig. 1C) [17, 18]. This unique firing pattern suggests a novel biological function related to the processing of sound that differs from the typical pattern of firing responsible for binaural hearing.

Although burst firing in mammalian sensory systems is not uncommon [19-24], it was previously unobserved in the chicken auditory brainstem. This new pattern of firing suggests optimisation for an aspect of sound processing not well understood. Nonetheless, it argues for conserved functions across vertebrates for similar sensory encoding of the surrounding environment.

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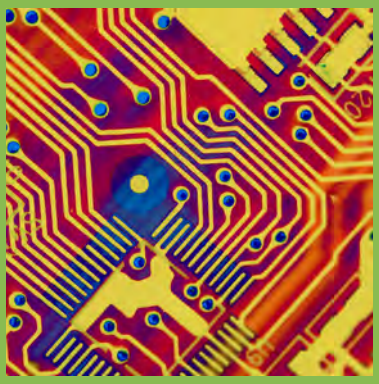
Northwestern University

Jason Tait Sanchez, Ph.D., CCC-A, FAAA
Assistant Professor
Northwestern University
Tel: +1 847 491 4648
jason.sanchez@northwestern.edu
http://caplab.northwestern.edu/









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Preventive care for people with arthritis and other musculoskeletal conditions

Versus Arthritis underline the importance of forward planning for improved preventive care for people with arthritis and other musculoskeletal conditions

Last year, Central Government committed to improving the quality of life for people living in England by examining ways to ensure individuals could look forward to five additional years of better health and independence. These commitments can be seen in its industrial strategy in support of healthcare. The green paper published by the Cabinet Office and the Department for Health and Social Care (DHSC) in July this year is the beginning of a consultation period to support the general population in having five additional years of a healthy life.

For several years, it has been thought prevention is the foundation of addressing challenges evident in countries like England with ageing populations and where multimorbidity (including mental health issues) and physical inactivity are ongoing. In 2014, the five-year forward view for the NHS emphasised the essential need for prevention. Last year, the DHSC produced Vision which highlighted a collection of case studies to illustrate and promote the need for prevention. In July this year, we saw the publication of the prevention green paper, Advancing our health: prevention in the 2020s. The green paper recognises musculoskeletal (MSK) and mental health conditions as the leading causes of people living for years with a disability.

Musculoskeletal health is maintained through a preventive (public health) approach

Dr Laura Boothman, Senior Policy Manager at Versus Arthritis, advocates for improved support for people with arthritis and says, "Good general health starts with good maternal health. Studies indicate the health of mothers can have a lasting impact on the health of their children. We look at prevention as being essential at every stage of life."

Physical activity and maintaining healthy weight support good musculoskeletal health

Adopting healthy lifestyles will likely facilitate a better quality of life later on. The green paper's reinforcement of the importance of regular physical activity is welcome. The UK Government is working with charities like Versus Arthritis to encourage people of all ages to include some form of activity in their everyday lives.

> "Treating symptoms in isolation doesn't offer a solution to deeper issues. Knowledge, resource and awareness will inevitably be the foundations for a shift in the model of how patients access support to prevent further damage resulting from musculoskeletal conditions."

Dr Benjamin Ellis, Senior Clinical Policy Adviser to Versus Arthritis and consultant rheumatologist, says, "If someone has been diagnosed with a condition that affects their joints, the most important thing they can do is to maintain and increase the amount of physical activity they do."

People with arthritis should be supported not only to stretch but also undertake activity that builds core strength. Everyone should be active daily; this can mean something other than an exercise routine such as regular walking, cycling, or doing housework or gardening.

Regular physical activity supports maintaining a healthy weight. As well as being good for the body, exercise also supports improved feelings of wellbeing.

Healthier workplaces can allow people to stay in work for longer

According to the Office for National Statistics (ONS) the average person in the UK is employed for 37.5 hours each week, but this can be as much as 48 hours weekly dependent on their type of employment. Not all jobs are office-based and some people have different working patterns; for example, freelance or shift workers. As people of working age can spend the majority of their time at work, the workplace is a vital setting to apply best practice advice to encourage people to look after their musculoskeletal health.

> "People with arthritis should be supported not only to stretch but also undertake activity that builds core strength. Everyone should be active daily; this can mean something other than an exercise routine such as regular walking, cycling, or doing housework or gardening."

Through his clinical work providing care for people with arthritis, Dr Ellis sees the importance of supportive conversations that allow people to be honest and open about their needs. "People should feel free to talk – whether that's with their healthcare provider or in the workplace – so they are able to discuss what they need to maintain their independence at work and home."

Individual healthcare concerns can present obstacles to remaining in work and for those new to the job market, these concerns can cause apprehension about employability. Musculoskeletal conditions can reduce mobility and can compound other long-term conditions like mental health. Research indicates people with musculoskeletal pain are twice as likely to experience signs and symptoms of mental health challenges such as anxiety.

Yet, for some people who are just joining, or perhaps trying to rejoin, the workforce health problems can be a barrier to gaining and retaining employment. This is particularly the case for those living with long-term musculoskeletal conditions such as arthritis, fibromyalgia or mental health conditions such as depression. It is reassuring Government are exploring offering support to enable workplaces to become more flexible and accessible for those people who can benefit from this the most.

"The law requires employers to make 'reasonable adjustments' for people living with a disability, which includes many people with arthritis," says Dr Ellis. "Depending on the person and their job, this could include reducing the physical requirements of their role, being flexible about working hours and location, or providing specialist equipment."

Getting prevention wrong isn't an option for the health service

While the prevention green paper has indicated regular health checks being an objective in improved patient care, ideally, these health checks would do more for people with arthritis.

Treating symptoms in isolation doesn't offer a solution to deeper issues. Knowledge, resource and awareness will inevitably be the foundations for a shift in the model of how patients access support to prevent further damage resulting from musculoskeletal conditions.

The Government's target is fifteen years to achieve the goals set out in this year's official green paper. Poor musculoskeletal health and arthritis can stop individuals from living their lives. To allow people to continue living as independently as possible, working and enjoying their lives, they require access to appropriate services that support, acknowledge and address individual needs. ■

Versus Arthritis
Tel: +44 (0)300 790 0400
enquiries@arthritisresearchuk.org
www.versusarthritis.org
www.twitter.com/VersusArthritis

The mechanisms that govern skeletal muscle function

In this second interview, Professor Dr Martin Flück reveals how his research aims to shed light on the mechanisms that govern skeletal muscle function in health and disease, with the goal of translating the findings into more effective clinical applications

To kick things off, Professor Dr Martin Flück explains how the research at the Laboratory for Muscle Plasticity at Balgrist University Hospital aims to shed light on the mechanisms that govern skeletal muscle function in health and disease, with the goal of translating the findings into more effective clinical applications. Martin notes that the approach of a head of a department is to make a patient-directed question that you must elucidate in a laboratory setting and he adds that the mechanisms in this respect need to be described in a coherent manner. This is because the words used to describe active processes when it comes to the muscle can be wrongly used and do not match what we would use to describe the biology of the patient. Martin then continues these themes in his own words, including the importance of accelerating translation for the benefit of the patient.

"We have been investing much in rediscovering older ideas – ones that surgeons originally rejected – based upon an incomplete description of the time course of muscle degeneration following a musculoskeletal injury. Previously, they looked at what happened in rotator cuff disease quite late in the degenerative process, which is quite common when a tendon ruptures, but much of the negative remodelling has already occured at this point. As such, things have to be checked early on which brings us back to a previous hypothesis that was rejected, Martin tells us. He goes on to expand this point in his own words.

"Basically, our approach is to translate the clinical problem in an experimental scenario that allows to test therapies for emerging bottlenecks in the recovery of musculoskeletal function of the patient. In this respect we now revisit early ideas for solutions of the negative remodeling of the injured muscle-tendon tissue composite which were set out 15 years ago, but rejected based on preliminary studies with negative outcome. We do this because we identify that the first window of opportunity for treatment after injury and reconstructive surgery, is short and not addressed experimentally, and consequently a number of active mechanism were overlooked.

This can be explained for example by the destruction of the cellular powerhouse, mitochondria, with immobilization that was not considered important; but we now know now that this exerts a dominant negative influence on the maintenance of muscle mass and fatigue resistance. Based on these findings one can reasonably argue that the treatment of disuse-related aspects of musculoskeletal disease, such as after tendon rupture, should start early, before the deterioration of clinical endpoints such as a loss in strength and fatigue resistance of muscle can be diagnosed and established as a chronic disability.

We also have a window of opportunity here to translate what we see in other muscle affections, such as during recovery from anterior cruciate ligament injury and repair and cardiovascular disease (CVD) that also involves the deconditioning of peripheral skeletal muscle (Flück et al, 2018). The critical factor here is how long the muscle is in a semi-stable state after an injury before it enters into a devastating spiral of muscle wasting. So, we aim to provide evidence in a coherent manner for how many days and weeks you can keep using the muscle before surgery needs to takes place. We now know, for instance, when muscle loss occurs and when it transfers into fat."

The power of medication and the importance of timing

While it is not one of his main priorities, Martin then shares his thoughts on educating the patients in this respect, as a dentist would when advising that teeth should be brushed three times daily but if one does not follow such advice then things will go bad. When it comes to translation for the benefit of the patient, Martin believes that while very simple forms of medication are available, such as steroids, there are new drugs on the

market that have passed governmental tests, and as such, their use is safe for humans to ingest.

Martin's opinion is that the power of existing medication can be improved by timing when it is taken so that muscle deterioration can be delayed. For example, if medication is administered under neuromuscular electric stimulation during the first two weeks after injury when surgery typically does not take place because the patient is in a lot of pain and experiencing tissue swelling. This approach is the way forward, according to Martin, who adds that he works hard with the surgeons because they are not used to working in such a manner, so a rethinking of priorities is therefore essential when you have the first meeting with a patient.

The benefits of excellent research facilities

The conversation then turns to explore Martin's thoughts on the superb new research facilities at the Balgrist Campus, and the benefit they have had on the valuable work and research at the campus. We find out how different parts of the Balgrist Campus are grouped together to enable easier access to research facilities and the pipelines are, therefore, tighter. In addition, there are other routines which allow for the acceleration of research because new investments have been made for the functional exploitation of muscle structure during movement.

Martin says that while his research output has not yet concretely benefited from the new facilities, interactions with other scientists who carry out anatomical measurements of the muscle has been a plus for him. "It is much easier for the students or researchers to train using these methods to measure muscle volume, get a 3D image and analyse the muscle. The facilities are good because they are open during weekdays and the weekend so people can come in and get things turned around."

State-of-the-art methods and technologies

This compelling interview continues, with Martin keen to detail the very important role that state-of-the-art methods and technologies play in the field of muscle research when it comes to the work taking place at the Balgrist Campus and in their fruitful cooperation with the Functional Genomics Center of the University of Zurich/ETH. Knowledge gathering can be accelerated, Martin reveals, in terms of exploiting paradigms in more breadth and in a higher resolution. State-of-the-art methods and technologies enable the measurement of multiple species and the use of powerful tools that enable researchers to work at a very fast pace. Still much work needs to be done in the field, Martin underlines.

"We still need good knowledge on the cell, biological, chemical and anatomical aspects of disease because it can be misleading to rely solely on results from one novel method. An image tool can always be used to draw conclusions about the raw numbers but nevertheless, combining that in a very elegant approach that relates to a systems biology that people advocate was raised at a conference around 11 years ago (Flück et al. 2008). "Now, we get biomarkers that allow us to screen patients out of the acceleration of numbers that we can relate to the relevant sizes of muscle, and we can more easily determine something in blocks, for example, or by a simple genetic test."

Personalised sports medicine and exercise rehabilitation

When it comes to disruptive ideas for personalised sports medicine and exercise rehabilitation, Martin says that one of his thoughts around this is the problem of getting economically viable pipelines established for medics. If it be for reasons of wisdom, or economic causes, the medical profession has typically been shy when it was to implement paradigm shifting approaches this demanded the reconsideration of established clinical routines. Now, it is about how a patient is aware of a problem and goes to a doctor to seek a solution. Sometimes, a doctor has a fair and good knowledge, but a researcher can be very well-informed about an aspect of health that perhaps a doctor doesn't know about. It might be that a doctor needs to do a literature search but although ultimately powerful and justified, this slows down decision taking. The latter in fact is a very active area of Research and Development in the Polytechnical School of Zurich (ETH) to identify faster and more comprehensive ways to approach a disease, Martin notes.

"Here, progressive methods could be used for other treatments even if it is not generally accepted nowadays. For example, if you had a bone fracture as I did, would you only do the training they tell you to do or would you do more, especially if you are experienced in physical training and know the limits of (your) human performance and capacity for the improvement through the stimulation of muscu-

loskeletal plasticity? Would you train hard to ensure a better recovery? Or do you want to get access to treatment that some people are using, such as biohacking that concerns legally allowed biological principles? For example, there are ways in which people can enrich their stem cells and reinject into them during training.

"Gene therapy won't solve everything and when looking at this field of atrophy, it needs to be administered in doses because that is how we grow. We renew, or grow, our active muscles one by one, 1% every day. Using this method repeatedly is way too much for the health system, indeed, we don't visit a doctor daily for two years, so we may anticipate to inject the agent in small doses. People who do biohacking reinject their stem cells when training daily for one month and then either stop or continue. This is not good for control and it is questionable if you carry this out in large numbers. But this is how these processes work. Improvements in strength and endurance rely on adaptations in muscle and tendons to (daily) repeated stimuli that if reach a specific threshold of mechanical or metabolic overload. The potency of it is enhanced by a high load of medication but the problem is that it uses far too many resources from the perspective of the health practitioner. Certainly, it is getting too expensive, so how do we deal with that? There will be big solutions to translate and in some cases, to abandon stem cell gene therapy for patients with many risks; but if it works, it will be quite disruptive. Martin then details his thoughts on rehabilitation after muscle injury occurs.

"Another more practical consideration is the contribution of the chiropractor or physiotherapist in rehabilitation. In the U.S., as the American Academy of Orthopaedic Surgeons sees it, the post-operative rehabilitation is conditioned by new ideas on the load, the intensity and volume of training. Physiotherapy often takes over that part but may overrule the researcher and possibly the orthopaedic surgeons because they have greater experience, and the pharmacist has even more experience of the drug.

"The well-trained physiotherapist is knowledgeable about rehabilitative interventions the patient should do post-operatively during musculoskeletal rehabilitation to achieve maximal benefit. The physiotherapist will do what is allowed in the window of intervention for the patient but maybe it could be done more aggressively and earlier? We have seen how in some hospitals in Germany, that certain post-operative interventions are starting much earlier to allow lymphatic drainage and reperfusion, for instance, after anterior cruciate ligament surgery. We know that this is very beneficial for healing from the experience of other surgeries as it is applied worldwide. So – this is something that we should actively pursue – that the physiotherapist or the people with knowledge of that aspect have more to say. This is the current practice of the American Academy of Orthopaedic Surgeons and hasn't yet been fully carried over to larger parts of Switzerland.

"What is also a problem is that because there is an economic pipeline, defining within which duration post-operative interventions can be performed in a hospital setting. New knowledge on therapeutic interventions which would extend beyond this window, or which are complicated to carry out in ambulant sessions of rehabilitation, may fall out of consideration for an implementation. This is particular concern for the reconditioning of an atrophied muscle, which must be tackled as early as possible by enhancing (or mimicking) the mechanical and metabolic load of an active muscle. There is a classic study from a famous English researcher which clearly shows that immediately after bone fracture, the contractile activity of concerned muscle groups must be increased for instance with sessions of neuromuscular electric stimulation (NMES) to maintain its protein balance."

Martin adds that studies have been done around these aforementioned areas but they had not been carried out for a long enough duration to really gain benefit from. NMES may be used for some very high profile sports individuals, such as the number one acrobatic skier who has treatment at the Balgrist University Hospital and uses EMS for an hour or two daily which works. While there are not enough resources to understand how it works, the patient needs to be willing to do NMES for many months or years as shown successfully in rare cases of tetraplegic patients, Martin stresses, which is disruptive.

"I know of athletes using EMS at night and I know it works but there is a big disconnect between the basic knowledge and how you apply it. Only committed people use EMS, often externally through Balgrist University Hospital. The patient will stay in the

hospital for a month and this approach works but this method it is only disruptive if it is translated to all patients and the benefit for society would be great."

The priorities for musculoskeletal disorders

Martin then sheds light on the priorities ahead for the diagnostics, treatment and rehabilitation of all musculoskeletal disorders. He says that his priorities for the future are very practical ones, in terms of the areas identified in this interview which need to be pursued. A willingness to change the system is needed, Martin notes and adds that if a treatment is available, it is important to ask at the Balgrist University Hospital with whom one can collaborate to apply such a genetic test. This involves much rethinking of the legal procedures when it comes to data protection and risk around genetic tests, Martin tells us.

In closing, Martin underlines that there is an issue today around health insurance because you cannot fully evaluate people in terms of numbers. Martin asks us to imagine that if we own a car and there is a problem with it then we go to the garage to get it repaired so that it works properly. This helps us to understand Martin's areas of research, and that Balgrist University Hospital sends out people who can walk again even though they may have a functional deficit following treatment but thresholds are not set to provide the patient with a map of the individual aspects of its musculoskeleton which require further improvement through therapy and training to empower a full regain of functional work capacity. Martin develops this point and adds his concluding remarks to this in-depth interview.

"Translating effective measures for the patient is a priority, so that they recover and that the form of treatment given is acceptable, such as gene therapy. Of course, gene therapy is far too expensive but the question is how can you do that? Do you have a risk priority in some areas? Or do you have the basic genetic tests that predict that such an approach will not help some patients, the health system or even the hospital?

"The priority must be to substitute for a subtle, often unnoticed, genetic deficit with an effective treatment which is what we do in the cardiovascular field, where with a non-responder to rehabilitation we try to have another treatment that the patient can respond to.

"Finally, I want to add that I am not connected with my European colleagues who have two approaches. One is a centralised setting tied to the way the state is organised, such as in the UK, the Netherlands and Scandinavian countries that rely on an institutional monarchy who have specifically robust, but sometimes rigid, ways of tackling some diseases. But interestingly, there is a disconnect in terms of what we aim to do in Switzerland where we have a federal system to gather information and administer a solution in a totally different way.

"In the UK, for example, there are the state organs to indicate how to pursue new treatments best based on a centralised database. In Switzerland, we gather information from our individual datasets and I see from my experience of working in different cultures that despite the possibilities for innovation provided by the latter approach, it sometimes lacks effective power for translation on a large scale. We need a solution to direct preventive and curative treatments in a more individual and economically viable manner to the entire spectra of the population. But to do so, we should combine a well-informed population-based approach with the innovative powers of an individualized approach, possibly by changing the organization of the health care system."

Laboratory for Muscle Plasticity

The Balgrist

Professor Dr Martin Fluck
Laboratory for Muscle Plasticity
Balgrist University Hospital
Tel: +41 44 510 7350
martin.flueck@balgrist.ch
https://www.balgrist.ch/en/

Tackling the growing burden of brain disorders in Europe

Frédéric Destrebecq, Executive Director of the European Brain Council explains the importance of tackling the growing burden of brain disorders in Europe

Over the last decades, neurological and mental conditions have steadily progressed to become the leading causes of disability-adjusted life years (DALYs) and the second leading cause of death worldwide. In Europe alone, an estimated 179 million Europeans live with brain disorders and 1 in 3 are set to live with one within their lifespan. Every year, treating brain conditions accounts for 35% of Europe's total disease burden with a yearly cost of €798 billion, of which 60% are related to direct costs (both medical and non-medical) [1,2,3,4], which, in spite of the magnitude of these numbers, are still considered to be underestimated and outdated. New epidemiological and economic studies are currently underway to analyse the extent of this burden on European and global society.

The Global Burden of Disease study (WHO, GBD 2016) estimated that neurological disorders were the cause of 276 million DALYs (11.6% of global DALYs for all diseases) and 9 million deaths (16.5% of total global deaths in 2016). Neurological disorders were the leading cause group of global DALYs and second leading cause group of deaths in 2016, while mental disorders accounted for 13% of DALYs [5]. This high burden [5,6] may be surprising as there is a general lack of awareness on the pervasiveness of brain disorders.

However, the growing number of citizens being diagnosed with brain conditions makes clear that the burden of these diseases place on society will not change its course. This burden is continuous due to the epidemiological transition from acute to chronic diseases and the increase in life expectancy, but also because of several socio-economic, environmental and behavioural health determinants.

National brain plans

It is clear that prompt action is needed at all levels. With health being a member state competency, this lack of awareness, prioritisation and disjunction in addressing the burden grows only stronger. Robust strategies at a national level and strong EU-wide coordination efforts are needed to effectively address the burden of diseases, particularly those reaching concerning levels of burden, such as brain disorders – neurological and mental alike. In 2015, the European Brain Council called on the European Union (EU) Member States to work closely with patient representatives, scientific societies and clinicians towards designing and establishing National Brain Plans, which aim to provide a holistic strategy to accelerate brain research and reduce the impact of brain disorders. Norway and Poland have spearheaded the launch of National Brain Plans, which constitute a key tool for supporting brain research and improving the quality of treatment. By countries (either EU or non-EU) recognising the brain as a priority, the urgency of addressing the burden is demonstrated and can play a major role in convincing the Member States to push the brain to the top of the EU research and health agenda.

Calls for increased funding: Counting down to zero

Horizon Europe is key in playing a positive role in addressing the burden of brain disorders, though the mention of health research – or brain research, specifically – is scarce and the recognition that funding in this field has continuously dropped over the last three Framework Programmes is neglected. In fact, this budget confirms a relative decrease of funding over time and across Framework Programmes, as health was previously allocated 12% under the 7th Framework

Programme, 10% under Horizon 2020 and now 8% in the Horizon Europe proposal [7].

Despite the progress in medical science during recent decades and recent breakthroughs which have provided a powerful dual opportunity to relieve the societal burden of neurological and mental disorders and innovate at the frontiers of technology, the inherent complexity of the nervous system has hampered our translational capacity and the vast majority of brain disorders remain without efficient cures. In order to ensure that Horizon Europe becomes a robust instrument for supporting brain research, budgets need to match the challenge. The €7.7 billion provisionally allocated to the "health" cluster under Pillar II is not commensurate with the total budget increase and will clearly be insufficient to effectively address the societal challenges associated with health research.

Brain, Mind & Pain

The reestablishment of the Brain, Mind & Pain MEP Interest Group is a positive sign that the newly elected European Parliament sees the importance of the group. The Group's first course of action was to release its Book of Evidence for the 2019-2024 mandate, which outlines clear focus areas and proposes recommendations for policy actions, which, if implemented, would significantly improve the quality of life for people with neurological and chronic pain disorders, as well as their families and carers. This Book of Evidence and the work of the BMP Interest Group as a whole contributes to the vision of the brain community on the reorganisation of care systems and services to respond to the growing unmet needs of patients.

The value of treatment

Discussions on healthcare focus too often on the increase in per-person healthcare cost rather than on the benefits of better health through early detection and early intervention. It is, therefore, important to emphasise on the need for more value-based and patient-centred care as well as strategies of early diagnosis and intervention, which proves to be cost-efficient and cost-effective in the long run [8]. ■

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Frédéric Destrebecq
Executive Director
European Brain Council (EBC)
Tel: +32 2 513 27 57
info@braincouncil.eu
www.braincouncil.eu
www.twitter.com/EU_Brain

Turning left, right or going straight – using elementary navigation decisions to understand brain function

Dr Stanley Heinze, Associate Professor at Lund University's Department of Biology, underlines his fascinating work on neuroscience, notably using elementary navigation decisions to understand brain function

This morning, I closed the front door of my house, locked it and turned around to get to work. Nothing unusual, but from the perspective of my brain there are a number of challenges to be solved within these few seconds. In principle, physical cues from the environment reach my sensory organs, my brain extracts meaningful information from these cues and transforms them into commands for my muscles. Naively, one could assume that identical sensory input would trigger identical behaviour. Yet, when facing my door, my brain instructs me to turn around and get on my bike in the morning, but to open it and go through in the evening. This is because the two views of the door are seen in different behavioural and motivational contexts (e.g. time of day, my hunger state and the knowledge of how I got into the situation).

But how do I decide what to do? In principle, the brain has to assess the current state of the world based on sensory information from the environment and compare it to an internally generated, desired state of the world. Any mismatch between the two will trigger a behaviour to compensate for the discrepancy between what I perceive as my current world and what I would desire this world to be like. How is this desired state of the world determined by the brain? In other words, how are the goals of my actions encoded?

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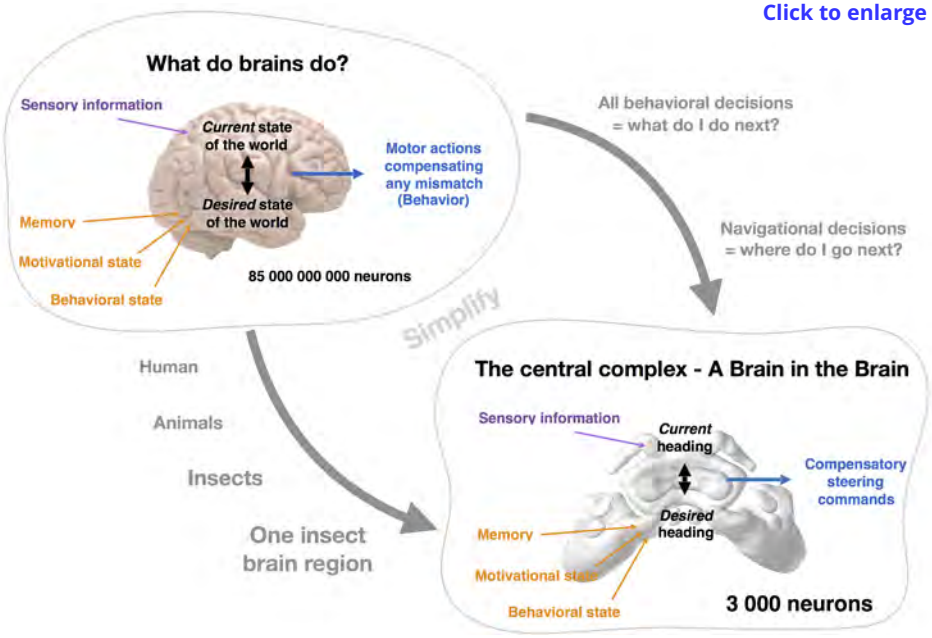

Figure 1: Towards the neurobiological basis of behavioural decisions.

In humans, the answer to this question has captured the attention of philosophers and scientists since ancient times, as it ultimately relates to the concept of whether there is free will and what role conscious experiences play in how we decide upon our actions. The problem in trying to understand how our brain generates these representations, determines goals and makes decisions, is that there are 85 billion neurons in our brain, linked by more connections than there are stars in our galaxy. This results in a neural network of enormous complexity with millions of neurons involved in any of the mentioned tasks. If we would like to understand the fundamental neural processes that lie at the very heart of how brains control actions based on internal goals, this complexity has to be reduced. This is what I do in my ongoing research.

A brain in the brain

In my research group, we tackle the problem of goal-directed behaviour in the context of navigation. The ability

to move from one place to another in a planned way is one of the defining features of most animals. Navigational decisions are, therefore, one of the most essential decisions that determine an animal's chance of survival. This applies also to us humans, as most of our momentary decisions revolve around the question whether to turn right, left, or continue to go straight. If you break down any navigation behaviour into a moment to moment basis, many can be simplified as long series of elementary navigation decisions. For these decisions, the desired state of the world simply becomes a desired movement direction. This direction has to be compared to the current body-orientation and any mismatch can be compensated by a simple steering manoeuvre. When these momentary steering decisions are chained together over time, a coherent strategy for navigation will emerge, only depending on which rules are applied to determine the desired headings. Therefore, the abstract concept of comparing the current and desired states of the world is essentially reduced to aligning two angles: the goal direction and the current heading.

Whereas this reduction in complexity is important to develop a tractable strategy to unravel the neural basis of behavioural decisions, determining navigational goals remains a highly complex task that requires many millions of neurons in the human brain and that depends on memory, internal state and highly integrated sensory information. To realistically pursue the goal of understanding this process on the level of individual neurons, my research group works on insects, more specifically we focus on a single brain area in the insect brain, the central complex (CX). This region only consists of around 3,000 neurons

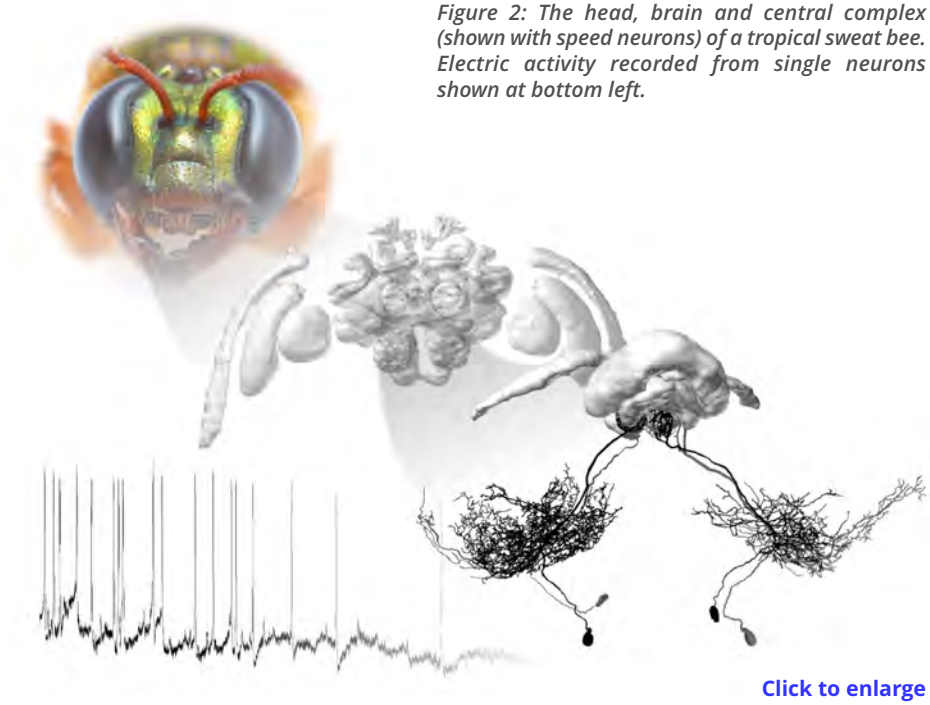

Figure 2: The head, brain and central complex (shown with speed neurons) of a tropical sweat bee. Electric activity recorded from single neurons shown at bottom left.

Click to enlarge

but is involved in all of the described processes. It integrates multiple streams of sensory information, it is involved in visual memory, regulating internal states (e.g. sleep) and contains neurons whose activity directly controls walking behaviour. Essentially, the CX carries out all the functions that we have defined as key functions of brains in general – effectively being a "brain in the brain".

Extracting a core circuit

The CX exists in all insects, independent of lifestyle, sensory environment and phylogenetic relationships. When comparing this region across species, its gross anatomy appears to be virtually unchanged since the dawn of insects more than 500 million years ago, suggesting that something about its function is truly essential to survival. A defining feature of the CX is its extremely regular, almost crystalline layout, consisting of 16-18 repeating vertical columns, which are intersected by horizontal layers. An interplay of two classes of neurons creates this regular array: tangential neurons transferring information from many different brain regions to this central integration hub and repeating sets of columnar neurons. The latter form stereotypical connectivity patterns within the CX and additionally constitute its main output.

The projection patterns of these neurons define the neural computations that can be carried out by the circuit. This structure-function relation is present in all brains and species but is extremely pronounced in the stereotypical projection matrix that has evolved in the CX. We found a striking example of this when plotting the tuning angles of polarized-light sensitive CX neurons against the anatomical location of their input branches. This produces a mapping of these tuning angles across the CX columns. When the animal rotates under the sky, activity should move around this brain region in sync with the animal's rotations. Essentially, we had found an ordered array of head-direction cells, which uses polarized skylight (and hence the Sun) as reference. Importantly, these head-direction circuits are virtually identical across

all examined insects. This discovery was the first building block needed to understand the neural circuits underlying navigational decisions. But how is the information about body orientation used to drive behavioural decisions?

A model grounded in biology

An insight was offered by a chance occasion. I was waiting for a bus after a conference in Italy. At the time, I wanted to see what the patterns of connectivity in the CX were, that could be inferred from anatomical data. I had an hour and nothing better to do, so I started to draw, producing a complicated and admittedly rather messy tangle of lines, which nevertheless looked oddly familiar. The day before, Barbara Webb, a robotics researcher from the University of Edinburgh, had given a talk about a model for path integration. Path integration is a computation that is employed by many animals, from insects to mammals and is used for finding back to a point of origin, for instance, a nest. As some insects, in particular, bees and ants, are exceptionally efficient when navigating with this strategy, I compared the individual elements of her model with my drawing, realising that every single detail could be matched to CX neurons. This was incredible – a model that had been artificially evolved by engineers to carry out path integration was embedded in the anatomical projection patterns of the bee brain!

Around the same time, I carried out electrophysiological recordings aimed at exploring how the internal compass of night-active bees differed from the Sun compass of other insects. As I could not find too many compass neurons, I used my virtual reality arena to test responses to optic flow fields that the bee would experience when flying. Indeed, I found neurons

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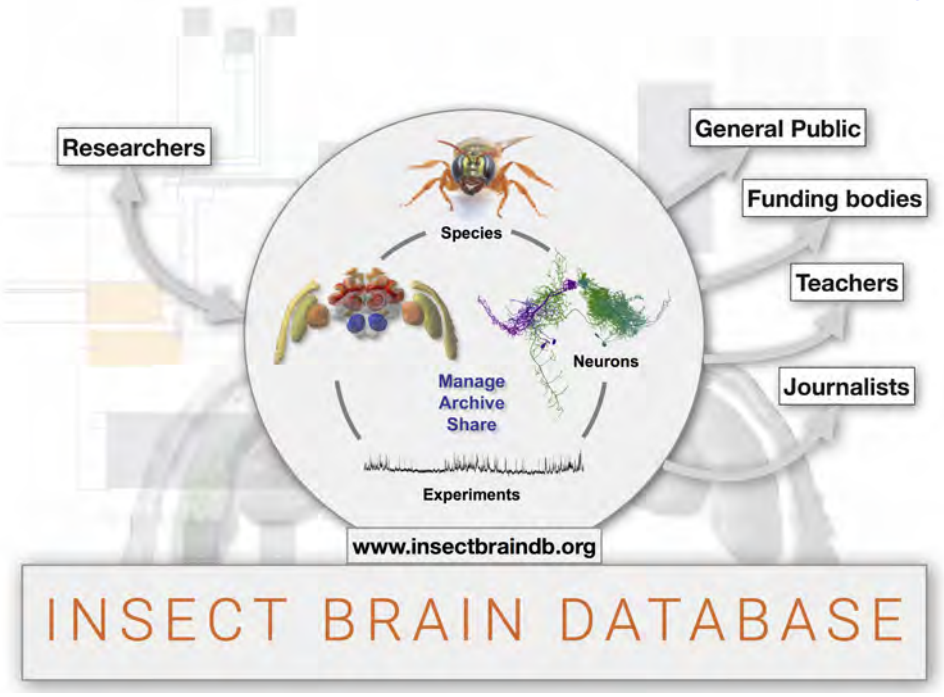

Figure 3: The insect brain database, an accessible tool for depositing, sharing and managing insect neuroscience data.

in the bee brain that responded specifically to simulated forward or backward flight. Moreover, they also projected to the CX.

Translational optic flow is used by honeybees to estimate their flight speed when using path integration. Whenever they move through their environment, the environment moves across their retina at a speed corresponding to their own speed. When this speed signal is integrated over time, the flown distance can be calculated. During foraging, this distance is combined with compass information to keep track of every movement after the bee leaves its nest. At each point during its foraging trip, this information, therefore, tells the bee the direction and distance of the nest – its home vector. When we combined these and the remaining relevant CX neurons into a computational model, this model reliably enabled a virtual bee to find back to its nest. When implemented on a physical robot, the path integration circuit mimicking the bee CX also resulted in reliable homing behaviour.

For the first time in any species, this circuit provides an anatomically constrained circuit for path integration, combining the above-described head-direction code with a similar pattern of activity that encodes the desired heading (i.e. the home vector). Both angles are represented as activity patterns, distributed across the CX columns. Steering neurons sample these two distributions and translate differences into steering commands. This circuit was what we had been looking for, a plausible neural implementation of elementary navigational decisions.

Challenges ahead

The described model circuit for path integration now provides the basis to develop a concept for how other navigation strategies could be implemented. All we needed to exchange was the source of activation in the memory neurons to generate a new

desired heading, which would be compared to the animal's current heading in the same way as during path integration, providing a basic framework to explain most directed behaviour.

While key parts of our model remain hypothetical, numerous predictions arise from the fact that all circuit functions are mapped onto existing CX neurons and, thus, can direct research to the most promising cell types. For the first time, we have an idea of what the conserved core circuit of the CX is and where the differences between species are, allowing us to observe the evolutionary tuning knobs that adapt a system to changing ecological needs.

In my group, we have started to dissect this circuit across six species of bees and ants, all differing in their mode of transportation (walking versus flying), as well as their favourite navigation strategies. Using serial section block-face electron microscopy, we are obtaining detailed connectivity maps of the CX to test circuit predictions arising from our models. A key functional prediction is that specific CX neurons encode path integration memory. This memory should depend on ongoing neural activity, similar to our own working memory (as opposed to long-term memory). We are using molecular, anatomical, physiological and behavioural methods to detect the memory cells, confirm the nature of the memory and to develop a simple model for working memory. Excitingly, our work also begins to address the neural switches that change the mode of the path integration circuit from recording (generating the home vector) to following (using the vector to steer homewards). In essence, these questions aim at understanding the motivational inputs that decide which behaviour is appropriate in which situation. These processes are homing in on our initial question: Why are we doing the things we do? Would it not be amazing if the basic processes underlying behavioural decisions have not dramatically changed over 500 million years and the brain of a bee could bring us closer to understanding our own human nature?

Reaching out

I have worked on insect brains for over a decade and hopefully, any reader at this point is convinced that we can gain substantial insight into how brains work from investigating these small but fascinating neural systems. Yet, if I had asked a general reader at the beginning of this essay if locust and bee brains could tell us anything about how we make decisions, the answer would have probably been a surprised: "Insects have brains?". At least this was the response I received when I gave a presentation about my research at my old high school several years ago.

To allow insect neuroscience to reach a wider audience, I have teamed up with a professional web-developer and generated a free, online tool to visualise, manage and share original research data. We are now hosting the most inclusive database on insect brain morphology and function, including data from 15 different species, based on work of ten research groups around the world. Not only are we granting access to 3D models, single neurons, images, functional information and raw data of individual experiments, but we have also developed intuitive visualisation aids that generate publication-ready illustrations for research, outreach and teaching. To enable non-anatomists to benefit from the database, we have also generated an intuitive graphical search interface. While we are still working out the details of the long-term financial sustainability of our website it is fully functional and accessible. Using our database, scientists, journalists and members of the public can explore neuroscience data, providing an unobstructed glimpse of what the product of our research is. Ideally, this transparency will generate a deeper understanding of the output of science, might spark interest in insect neuroscience and will hopefully enhance the appreciation for the invertebrate members of the animal kingdom.

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LUND UNIVERSITY

European Research Council

Dr Stanley Heinze
Associate Professor
Lund University, Department of Biology,
Lund Vision Group
Tel: +46 462 229 578
staney.heinze@biol.lu.se
https://braininbrain.org/
www.twitter.com/stanley_heinze

Current gaps and future opportunities in dementia research

Here, Hilary Evans, Chief Executive at Alzheimer's Research UK, outlines expert insight into where dementia research should move next

This year, Alzheimer's Research UK published the results of a detailed project to assess current approaches to dementia research. We spoke to experts in dementia research from universities, pharmaceutical companies and other charities and found a consensus that while dementia research is receiving greater support than ever before, there remain gaps in understanding and ways of work that must be addressed. These areas represent important opportunities to accelerate progress and bring about life-changing treatments for people with dementia.

The current crisis

The scale of dementia is now impossible to ignore. Globally, 50 million people are living with dementia, with that number predicted to triple by 2050. This sheer number of people with the condition cost the global economy $1trillion in 2018.

> "...a major gap exists between research funding for serious diseases. In 2016/17, cancer research received £269 million in UK government funding compared to £83.1 million for dementia in the same year."

Compounding this health crisis is a lack of effective treatments. Currently, while we can temporarily treat some of the symptoms of dementia, we cannot stop, slow or prevent the diseases, like Alzheimer's, that cause the condition. It has been 17 years since the last new drug for dementia was made available and we believe that people living with dementia and their loved ones deserve better.

Current gaps in dementia research

To bring about change, we worked with experts in the dementia field to develop a strategic action plan to address gaps in our current understanding. We have called for reform in six key areas to ensure we:

Hilary Evans, Chief Executive

- Investigate the effects of newly identified genetic risk factors on disease processes.
- Improve understanding of why some brain nerve cells are more resilient than others.
- Bolster early drug discovery work to identify the most promising new treatments opportunities.
- Select the right participants for clinical trials.
- Improve ways to measure how effectively drugs are working in people.
- Find ways to begin clinical trials in people decades earlier than we do today

Our research needs to focus efforts on the most important biological processes driving disease. This will give us the best chance of bringing about the life-changing treatments people with dementia desperately need. It will require us to think carefully about how we design

our clinical trials in the smartest ways to test potential new medicines.

Updating our approach

In 2013, the G8 committed to finding a disease-modifying treatment for people with dementia by 2025. Since then, research has moved on. While clinical trials of disease-modifying treatments have not yet borne fruit, we have learnt huge amounts about the complex diseases driving dementia.

But to continue making progress in research we must review what's working well and what could be improved. And we need to take brave steps to move things forward to bring about new medicines.

The recommendations outlined in our report are all steps that industry, charity and funders can make, through training, rewards and funding programmes. While they're bold steps, they are manageable and we must start to implement them at the earliest opportunity.

Speeding up progress

Progress in dementia research does not happen overnight - it requires commitment and a multi-faceted approach. We need to improve prevention strategies, work to detect the diseases that cause dementia earlier and expand our understanding of the biological underpinnings of disease at the same time.

An overarching resolution is to find new ways to incentivise collaboration between researchers, particularly between those from different scientific disciplines who may be able to offer new perspectives on the challenge.

We also need to efficiently and comprehensively share data at all levels across the scientific community. By standardising approaches to the way we collect and share data, we can more easily compare results and pick out important trends in the data, accelerating progress. It's a huge task, but it's one we must undertake together.

Funding makes breakthroughs possible

We know that research breakthroughs are made possible by sustained funding. Looking at cancer, in the UK alone, 50 years of committed and increasing investment from 1970 have led to a doubling in the cancer survival rate in this country. We hope to replicate this success for dementia.

But right now, a major gap exists between research funding for serious diseases. In 2015/16, cancer research received £269 million in UK government funding compared to £83.1 million for dementia in the same year.

Globally, we're seeing governments commit to increasing budgets for dementia research – the U.S. now spends $2.4 billion on dementia research and Canada has pledged to spend 1% of the cost of care on research. We must see the UK step up to join this global effort and commit to investing just 1% towards research to bring an end to the fear, harm and heartbreak of dementia.

We're doing our part to close the funding gap too. This year, Alzheimer's Research UK committed to spend a landmark £250 million in dementia research over the next five years thanks to our incredible supporters.

You can read our full report, here.

As Chief Executive Hilary has led the transformation of the charity to one of the leading medical research charities in the UK – seeing the charity more than triple its income in three years and, therefore, significantly enhanced the organisation's ability to fund ground-breaking new projects.

Alzheimer's Research UK currently funds 140 research projects with a network of over 2,000 researchers working on the causes, symptoms treatments and diagnosis of Alzheimer's.

Before joining Alzheimer's Research UK, Hilary led the campaigning work at Age UK, improving the lives of people in later life both in the UK and internationally. She holds an honorary doctorate in medicine from The University of Exeter. ■

Hilary Evans
Chief Executive
Alzheimer's Research UK
Tel: +44 (0)300 111 5555
enquiries@alzheimersresearchuk.org
www.alzheimersresearchuk.org
www.twitter.com/AlzResearchUK

What is the role of intramembrane proteases in Cancer?

Regina Fluhrer from the University of Augsburg and Bernd Schröder from the TU in Dresden discuss the potential of intramembrane proteases as targets for cancer therapies

Despite significant efforts and achievements cancer still represents the second most common cause of death in industrialised countries. Mutations and other changes in the genome of cells induce their malignant transformation which leads to uncontrolled proliferation and destructive growth. Survival, proliferation and migration of healthy cells are controlled by an intricate network of signalling pathways. Dysregulation of such pathways is an integral part of malignant transformation and contributes significantly to the loss of growth control and the ability to form metastases.

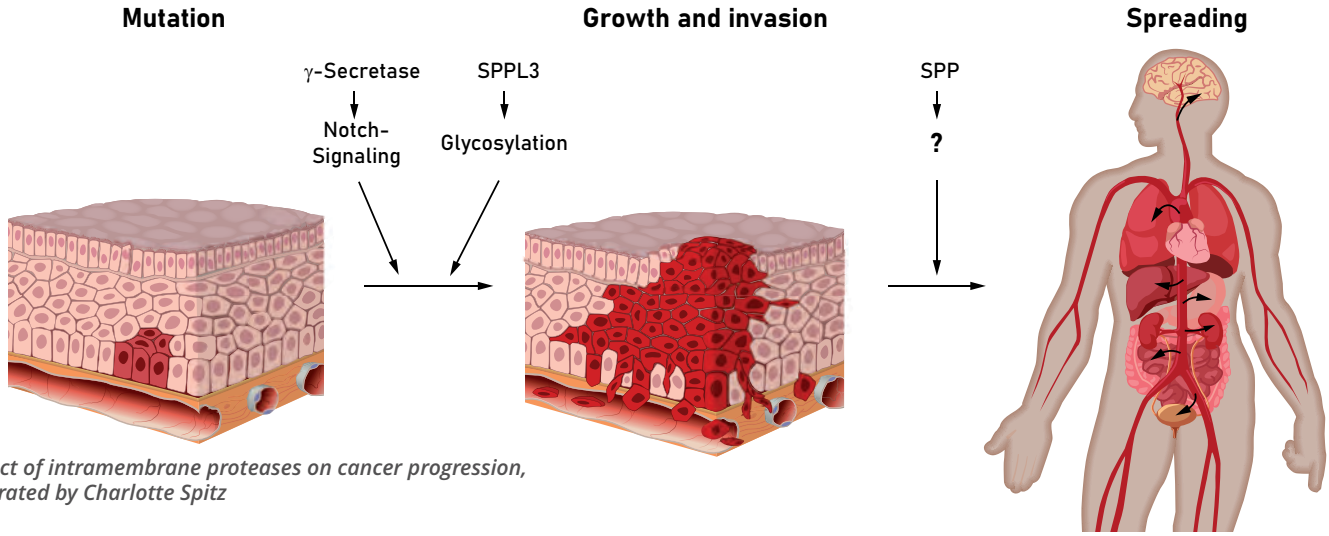
Intramembrane proteases are enzymes that cleave substrate proteins embedded in cellular membranes and release the cleavage fragments from the membrane (read more in the October 2018 edition of Open Access Government). By this, intramembrane proteases actively control signalling pathways as exemplified by the intensively studied Notch pathway (read more in the January 2019 edition of Open Access Government). Following activation of the Notch receptor by its ligand, this receptor undergoes a series of proteolytic cleavages culminating in the liberation of its intracellular domain into the cytosol by γ-secretase, an intramembrane protease, which is also involved in the development of Alzheimer's disease (read more in the July 2019 edition of Open Access Government).

Regina Fluhrer, professor of Biochemistry and Molecular Biology at the Medical Faculty at the University of Augsburg, Germany

Bernd Schröder, professor of Physiological Chemistry and Molecular Biology at the Institute of Physiological Chemistry at the Technische Universität Dresden, Germany

Over-activated Notch signalling plays a well-established role in carcinogenesis and tumour progression. In certain types of leukemia (T-ALL) over 50% of cases exhibit Notch-activating mutations which drive disease development. Therefore, different means of interfering with Notch signalling have been assessed. Pharmacological inhibition of γ-secretase blocks Notch signalling since translocation of the Notch intracellular domain to the cell's nucleus is dependent on cleavage of Notch by γ-secretase. Therefore, inhibitors of γ-secretase are evaluated in promising phase I and phase II clinical studies against different solid tumours and leukaemias. In particular, patients with a documented activation of the Notch signalling pathway in the tumour may profit from such an approach, possibly in conjunction with established treatment strategies. However, this approach may require further evaluation, since beyond the Notch receptor altogether more than hundred different proteins have been identified to be cleaved by γ-secretase. Among these are also several receptor tyrosine kinases, which can support proliferation and survival of cancer cells, but it is not clear yet if inhibition of γ-secretase cleavage will affect the signals induced by these receptors and how this will impact on tumour growth. Effects of these receptors may also differ between tumours of different origin and, thus, will require further clinical studies.

The reported anti-cancer action of certain γ-secretase inhibitors may in part also be supported by an accompanying action of these compounds on members of a mechanistically related protease family, the SPP/SPPL proteases. Among these, in particular Signal Peptide Peptidase (SPP) has been linked with cancer. SPP was found to be highly upregulated in lung and breast tumours. In agreement, SPP depletion significantly reduced



Impact of intramembrane proteases on cancer progression, illustrated by Charlotte Spitz

cell growth and migration/invasion capacity of tumour cells in animal models. Since currently no specific inhibitors of SPP suitable for *in vivo* application are available, a potential anti-cancer effect in humans remains to be determined. With regard to the underlying mechanisms, cleavage of different substrate proteins has been proposed to be responsible for the tumour-promoting activity of SPP. Therefore, further work will be needed to unravel this proteolytic network and its role in cancer biology as well as its therapeutic potential.

It is well established that a change of glycosylation patterns can significantly affect and modulate the behaviour of cancer cells. Sugar moieties are attached to almost half of all cellular proteins during their synthesis by a process known as protein glycosylation. This is also the basis for formation of the extracellular matrix, the material surrounding our body cells constituting a scaffold for their growth and migration. The extracellular matrix is formed by secretion of various glycoproteins from cells. The adhesion of cancer cells to this network as well as the composition of the extracellular matrix influence their potential to metastasize.

In this context, another member of the SPP/SPPL protease family, SPPL3, is of great interest to be explored, as it is a major regulator of cellular protein glycosylation (read more in the January 2019 edition of Open Access Government) and, thus, also impacts on the synthesis of the extracellular matrix proteins. In this regard, evaluating the impact of SPPL3 and a modulation of its activity on tumour cells is of great potential.

As these examples show, the role of intramembrane proteases in cancer is still emerging. These versatile enzymes regulate central cellular pathways, which also play a major role in tumour cells. Whereas the assessment of the therapeutic potential of γ-secretase in clinical studies is already quite advanced, our knowledge on other intramembrane proteases in this context currently only results from pre-clinical models or cell biological studies. However, based on these promising results it may be anticipated from further research efforts in this direction that intramembrane proteases will turn out to be attractive targets in cancer therapy in the future.

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Prof Dr Regina Fluhrer
Biochemistry and Molecular Biology
Faculty of Medicine
University of Augsburg
Germany
Tel: +49 /821/ 598 - 2069
regina.fluhrer@med.uni-augsburg.de
www.med.uni-augsburg.de/de/lehrstuehle/biochemie/

Distributive biobanking models: Why biospecimens need blockchain

Here, several experts from the International Society for Biological and Environmental Repositories provide a novel perspective around distributive biobanking models, including why biospecimens need blockchain

When you are sick, to determine what is wrong with you, a doctor will likely require you to give up a piece of your body (e.g. tissue biopsy, blood sample), some secretions (e.g. saliva, cervical swab) or some of its excretions (e.g. urine, faeces). They do this as 'biospecimens' are central to their understanding of human biology and the diseases we encounter.

At its core, 'biospecimens' contain the information that doctors and researchers use to understand what type of disease a patient has and to determine possible treatment options that should be used for their clinical management. Through advances in biotechnology, the information in the biospecimen can now be readily and routinely extracted leading to vast amounts of digital data being captured in machine-readable forms. This 'datafication' of biospecimens generates different types of 'omic' data (genomics, transcriptomics, proteomics, metabolomics, epigenomics) reflecting the molecular events ongoing in the disease. Or it may be information drawn from medical and microscopic analyses of images of tissue samples. When building a framework for personalised treatment of disease, the complexity of the biospecimen-derived information must be captured in meaningful and actionable ways. As the impacts of the use of digital information to the healthcare system have been emerging, personalised medicine will be directed by computational scientists and data analysts active in the biomedical domains. In doing so, tissue-based science is now an informatics problem.

The problem of centralising biospecimens

Within biomedical research, centralisation of its core activities into aggregated facilities or 'repositories', such as nodes, databases, or registries is a well-entrenched practice. Current tissue handling practices seek to aggregate biospecimens into giant freezers that are linked to databases of annotated clinical and 'omic' data, registries of patient information and research project ethical consent.[1] Over the past 20 years, aggregation of biospecimens into biobanks have emerged which, in the U.S., is anticipated to become a $2.7 billion industry by 2022.[2] Biobankers operate their repositories as largely autonomous self-governed entities that obtain their biospecimens through arrangements within pathology services or directly from surgery. Whilst the narrative around strategic planning recognises that 'biobanks are crucial for medical research,'[3] a bevy of reports highlight how low biobank utilisation fuels unsustainable biobank models.[4] Despite grand plans to aggregate biospecimens into ever- larger centralised facilities, they have not yet realised their potential. The reason for this is multifaceted and influenced by the following issues: parochialism in research, biohoarding of specimens without release to researchers[5], capacity issues, poor business models, separation of biospecimen from the patient record and disengagement of research from the healthcare environment.

> "We envisage biobanks would benefit from blockchain technology. Blockchain as an incorruptible shared digital ledger allows for the distributed, secure, transparent and robust transactions by tracking the secure, ethical transfer of biospecimens to researchers."

Centralised biobanking suffers from other disadvantages known to plague centralisation models. Specifically, biospecimen aggregation creates single points of failure within the system which require excessive protections and constant vigilance to maintain security. Centralised storage of biospecimen without clear motivations for their successful use leads to legacy collections that have no purpose, leaving unused

biospecimen-derived information, creating noise and raising the question of relevance. Finally, centralisation removes the biospecimens from their primary source, which is the patients themselves. This led to a loss of engagement of key stakeholders. The decision-making process reverts to an independent 'authority' who determines access rights, requiring donors to have unconditional trust in biobank practices and motives. In summary, aggregation of biospecimens into central facilities cacoons the information they could provide into systems that are controlled by a limited few who may censor the message biospecimens hold and thus dictate the research narrative whilst restricting open discovery and exploration by many others.

The decentralisation of biospecimens using blockchain

Bold and innovative strategies are needed for biospecimen derived informatics to impact digital health initiatives. Shifting aggregative biobanking to a model that manages biospecimens as an integral part of a digital health information flow will revolutionise how we learn from biospecimen-derived information. Distributed models rely on the presence of many independent participants that manage processes together through common standards performed in parallel. For distributed models to work, all components required for the system must be decentralised, including consent practices, ethics and governance oversight, patient engagement, biospecimen transfer logistics, datafication processes, quality management, research results dissemination and even clinical decision making.[6] Decentralised environments see processes distributed away from a central authoritative organisation or group, with decision making falling to a cooperative of people having different perspectives, leading to greater objectivity.

> "At its core, 'biospecimens' contain the information that doctors and researchers use to understand what type of disease a patient has and to determine possible treatment options that should be used for their clinical management."

We envisage biobanks would benefit from blockchain technology. Blockchain as an incorruptible shared digital ledger allows for the distributed, secure, transparent and robust transactions by tracking the secure, ethical transfer of biospecimens to researchers. This blockchain implementation was created to build trustworthy decentralised applications that run with no downtime, censorship, fraud or third-party interference which is

Continued on page 189 ➔

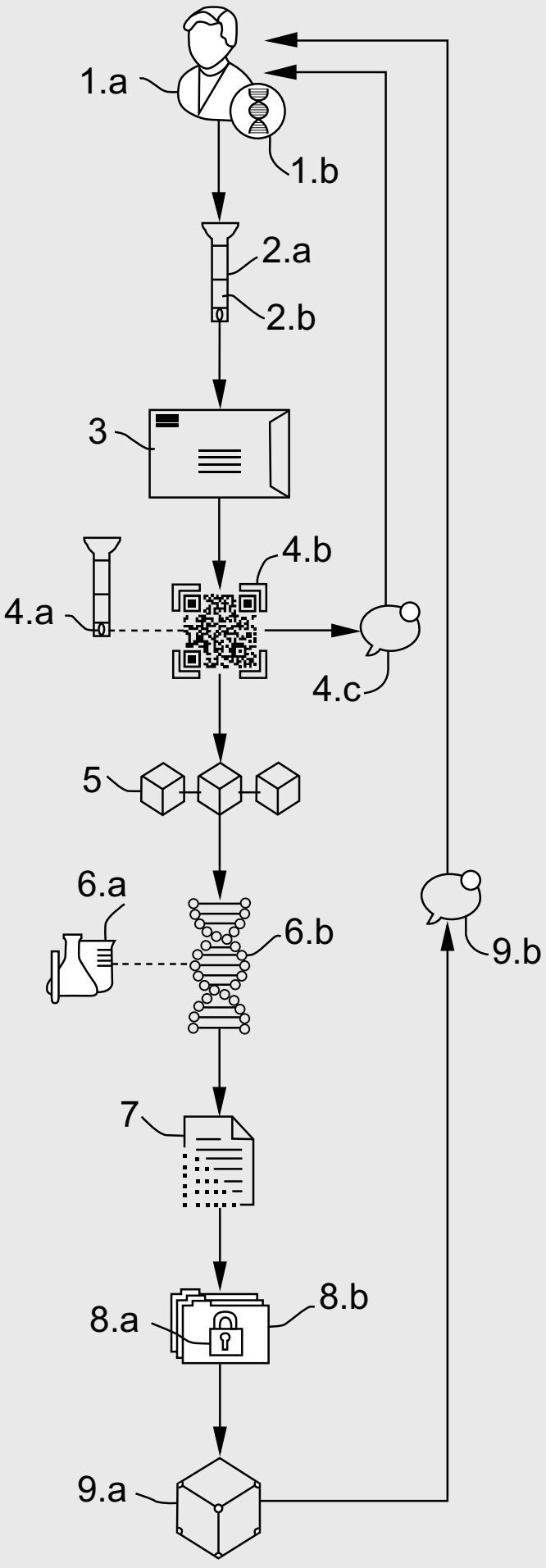

Figure 1: Proposed steps in a biospecimen-informatics blockchain developed by Genobank.io to tokenize biospecimens and its corresponding DNA/RNA datasets.

1. (a) The donor creates a "BioWallet" (Genobank's account) having a public address and private key. **(b)** The wallet encrypts user's private key with a pin code provided by the user & creates an empty unique digital repository for the coming "multi-omics" data sets.

2. (a) The donor deposits their biospecimen into a QR/Barcoded tube. **(b)** The donor scans the tube code creating a unique non-fungible token (NFT) in their biowallet containing information including GPS location, expiration dates, brand, date and time recorded as metadata.

3. The donor ships the biospecimen to an assigned biobank or laboratory.

4. (a) The biobank receives the biospecimien, scans the QR/Barcode and connects via internet to genobank.io **(b)** Each biorepository/tube is referenced to a specific BioWallet as a token where the owner of the biowallet is the only one that can receive, decrypt & share the corresponding data sets and messages. **(c)** Once the biosample is received by biobank, the donor receives a text notification or tokenized reward.

5. The transactions are recorded in a public blockchain specifying the use of the data criteria.

6. (a) Biobank/laboratory process the biosample and applies all the amplification or preparation libraries. **(b)** The DNA/RNA is extracted and the process digitised.

7. The DNA/RNA is sequenced using the best available technology.

8. (a) The digital raw data is generated **(b)** Raw data is encrypted using donor's private key and a non-fungible token is created to claim ownership of this data sets in the blockchain. Fungilble tokens can be created from this data sets to allow releasing serialised copies using the corresponding biowallet where the private key must be used to sign all the transactions.

9. (a) Encrypted raw data is stored in the assigned private decentralised digital repository **(b)** Donor is notified that their data is available through the encrypted private messaging system.



(Left) Daniel R. Catchpoole, (middle) Paul Kennedy, (right) Daniel Uribe

← *Continued from page 187*

ideal in the context of exploring human tissue within the research context. Use of smart contracts has been identified as enabling the management for human subject regulation allowing Human Research Ethics Committees and governance bodies to comprehensively, transparently, securely and automatically administer the requirements for research integrity whilst avoiding repetitive intervention between participants.[7] Blockchain is now being used to personalise biospecimen collection and distribution allowing donors to determine how their specimens will be used in research (Figure 1). Blockchain technology enables ways of synchronising data between participants within a system that is not influenced by suspicion. If tissue-based science is an informatics problem, then biospecimens should be the first block in the chain of information flow. ■

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Daniel R. Catchpoole
Head, Tumour Bank, The Children's Cancer Research Unit
Kids Research, The Children's Hospital at Westmead, NSW, Australia
daniel.catchpoole@health.nsw.gov.au
www.kidsresearch.org.au/research/children%E2%80%99s-cancer-research-unit/tumour-banking-biospecimens-research
www.twitter.com/kids_research
www.twitter.com/SCHNkids

Daniel R. Catchpoole & Paul Kennedy
School of Computer Science, Faculty of Engineering and Information Technology, The University of Technology Sydney, Sydney, Australia.
daniel.catchpoole@uts.edu.au
paul.kennedy@uts.edu.au
www.uts.edu.au/about/faculty-engineering-and-information-technology
www.uts.edu.au/staff/daniel.catchpoole
https://paul-kennedy.weebly.com/
www.twitter.com/utsfeit

Daniel Uribe
Genobank, San Francisco, California, U.S.
daniel@genobank.io
https://genobank.io/
www.twitter.com/duribeb

Discussion Think tank
International Society for Biological and Environmental Repositories (ISBER)
Tel: +1 604 484 5693
info@isber.org
www.isber.org
www.twitter.com/ISBER_ORG

Getting together in the biobank scene: BRoTHER brings biobank know-how to scientists, students and the public

Christoph Brochhausen, Max Babel, Tanja Neumair, Karl Friedrich Becker, Judita Kinkorova, Ondrej Topolcan, explain here exactly how BRoTHER brings biobank know-how to scientists, students and the public

It is well known that biobanks represent crucial infrastructures for precision medicine. However, scientists, students and the public are not totally aware of this fact. This may be one reason why the sustainability of biobanks all over Europe is not self-evident and why funding of biobanks remains a matter of debate.

Furthermore, the definition, understanding and the mission of biobanking is highly complex and heterogeneous. Also, this heterogeneity is not well known. Even if there are several integrating societies bringing biobanking communities from the different fields together, a real interaction of biobankers and biobanking is mandatory. Finally, scientists, students and the public are not aware of the innovative potential of biobanking with a view to cytotechnology, robotics and artificial intelligence (AI).

Besides sustainable financing of a biobank infrastructure, the acceptance of biobanking in the public is another essential pillar for the success of a biobank, especially for a clinical biobank since their repository is dependent on the donation of specimens by the patients and their consent to use these specimens for experimental research. Furthermore, the exchange of know-how is a crucial parameter to guarantee not only the continuous work with state-of-the-art methods but also to follow recent developments in targeted therapy, as well as new trends in the analytics of prognostic or predictive factors respectively. The last pillar which is essential to ensure the sustainability of a biobank, is the dissemination of the strategy, the methods and the activities of a biobank. This last point is a mandatory feature, on the one hand, to be attractive for and to get access to the potential participation in new experimental studies or trials initialised by third parties and, on the other hand, to ensure the long-term acceptance within patients in case of clinical biobank or within the population in the event of a population-based biobank.

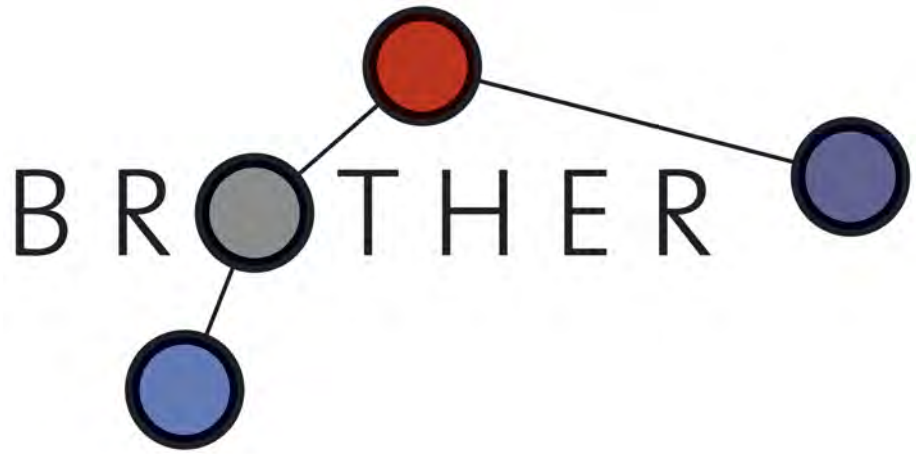

Fig. 1: The logo of BRoTHER represents the geographical location of the network partners combined with their corporate design colours. The logo represents both, the close connection of the partners and the openness of the network for new partners.

BRoTHER (fig. 1) represents a Bavarian Czech biobank network funded by the Bavarian-Czech Research Agency with finance from the Bavarian State Ministry of Finance, Development and Homeland to promote common biobank projects. This small biobank network consists of the biobank of the University of Regensburg (Germany), that of the Technical University Munich (Germany), that of the Faculty Hospital Pilsen (Czech Republic) and the Masaryk University, Brno (Czech Republic). A crucial focus in this network is given by dissemination and exchange of know-how. BRoTHER follows a unique strategy to disseminate and promote the ideas and the activities for innovative biobanking: With posters, presentations at relevant

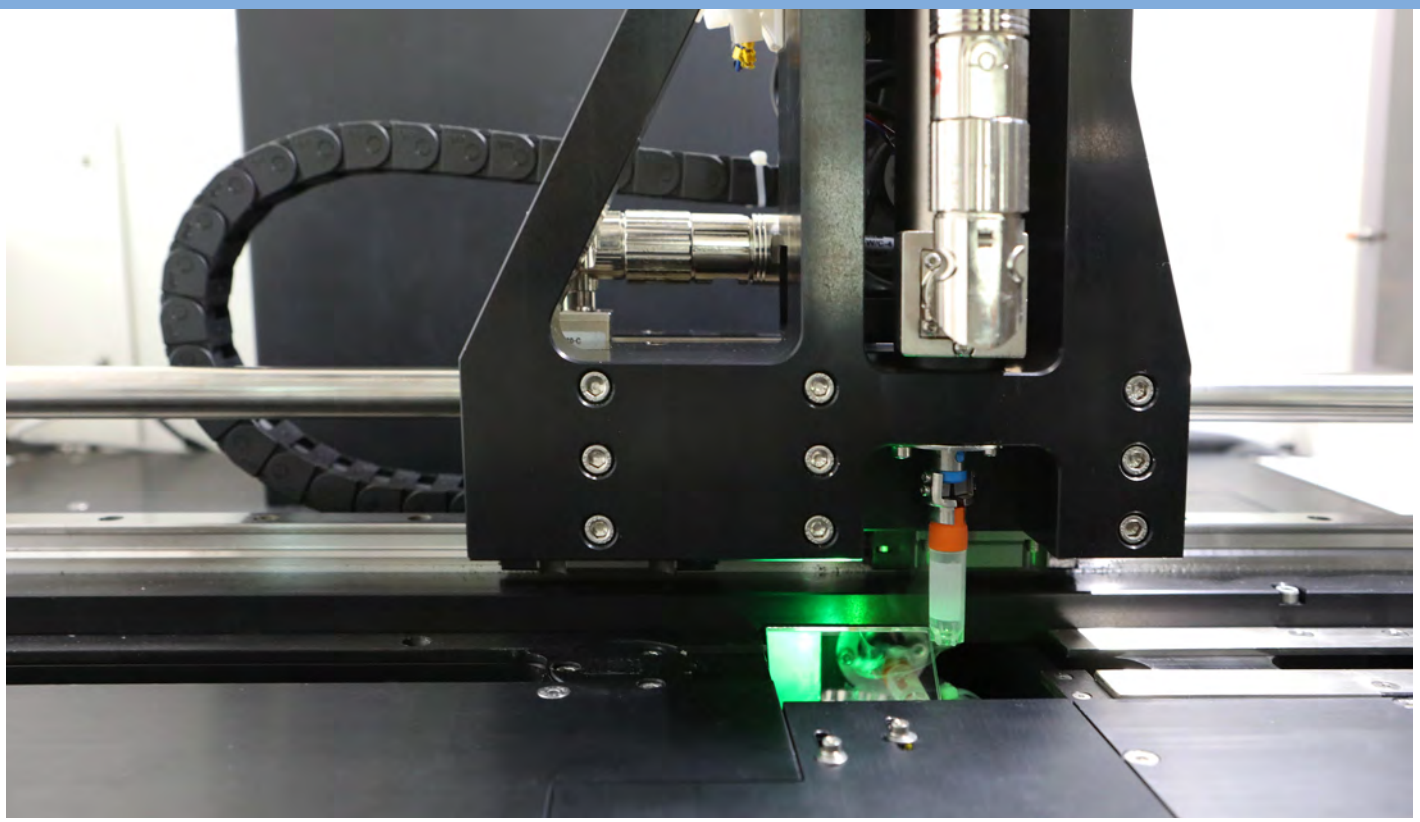

Fig. 2: Detail of a fully automatic storage system for biobank specimens with a so-called cherry-picking strategy, which means that every single specimen will be stored and restored. The specimens are labelled with code at the bottom and will be registered via scanning. The advantage of this modern Cherry-picking system from the Smart Freezer® is that in case of re-storing only the needed specimen will be moved. All other specimens will stay under stable storing conditions.

conferences and events, brokerage events and development, we address the scientific community. With information materials in the languages of the involved partners, namely in German, English and Czech, we address the broader public. In this context, this publication in Open Access Government is one way to disseminate our activities in biobanking. With that, we want to make BRoTHER known and attractive to the readership from the European Parliament, the European Commission but also for European and national research agencies.

Furthermore, the dissemination of biobank know-how to the wider public and our work on public relations is important for two reasons. The first is to stay attractive for potential biomaterial donors and get or to keep the acceptance of the biobank within the public arena. Finally, dissemination of biobank know-how will also be an instrument to enlighten the public about the need for biobanking, its role for personalised medicine and in modern biomedical research. To address this issue, we use not only press releases and short information, articles in magazines, journals and other printed materials published regularly both in Bavaria and the Czech Republic, but also public events such as a benefits concert, a plenary discussion with the public and public readings, events which were joined by more than 1,000 people coming not directly from a clinical context. In addition to that, our Czech partners provided national press releases to inform people about the most important initiatives promoted and organised as part of the project at the national level. Furthermore, cooperation with relevant associations, infrastructures and other relevant partners will be initiated to disseminate the information on the project and to open the space for future collaboration. In this context, the project BRoTHER and the need for interconnected biobanks and biobank research were presented to the public during the official opening ceremony of the biobank at the Faculty Hospital, Pilsen at the beginning of 2017.

The exchange of know-how is an important aim of BRoTHER which is realised on different levels: with Symposia and workshops, we address biobank staff and researchers. Our Symposia and workshops focus on new technology in biobanking such as cryobiology, IT, as well as AI and robotics (Fig. 2). They are organised twice a year, one with a Bavarian partner and one with a partner in the Czech Republic. The workshops are open for students and scientists working in the different aspects of biobanking. One important topic of the workshops is the practical work on different aspects of biobanking. The subjects of the workshops are:

- Biobanking data management;
- Techniques on Whole Slide Imaging;
- The effect of preanalytical for biobank specimen and;
- Ethical, legal and social aspects of biobanking (ELSI).

Fig. 3: Training session in the handling of biobank specimens during the student exchange programme at the Central Biobank of the University Regensburg. The students get hands-on training on the different aspects of biobanking. Here it is the handling for the nitrogen storage system.

Symposia are held once to twice a year in Bavaria and the Czech Republic. The Symposia aims to bring the students and scientist of the partners together with leading researchers in the different fields of the projects. The most important topic of the Symposia is the presentation of the recent research topics and research trends within the field of biobanking, as well as the exchange of knowledge. The first Symposium was held in the cadre of the Opening Ceremony of the Pilsen Biobank in 2017.

Furthermore, we have established a student exchange programme which facilitates students in medicine to obtain knowledge about biobanking since this important topic is not yet represented in the most curricula. Within the exchange programme, we organised a student summer school. In addition, the students learn more about the different methods in biobanking via hands-on training during site visits (fig. 3).

A crucial issue within the BRoTHER Consortium is learning from each other by working together. With a view of the different levels of interconnection and cooperation, as well as with a view to the harmonisation of biobank work-flows and processing, the project partners compare work-flows, analyse the ratio behind it and evaluate if these are in accordance with national and international standards in biobanking. In this context, our student exchange programme of graduate and post-graduate students represent an important element of this interconnected work. The students are properly integrated into the different aspects of the project work regarding harmonisation and digitalisation. They rotate from one partner to another and will be actively integrated into the project work and in the infrastructure of the different biobanks at the partner sites. With that, the students will become familiar with work-flow, the analytical methods and the standard operating procedures at the different partners of BRoTHER. Thus, they will learn more about the project partners, as well as the recent developments in innovative biobank technology including IT, whole slide imaging and robotics.

During the first three years of BRoTHER, two summer schools are organised, one in 2018 in Regensburg and the second one in 2019, in Pilsen. During the Summer School, we bring the students of the partner sites together and they present and discuss their activities and results with each other and leading researchers in the field. The idea is that the summer schools will be held at each partner site so that the opportunity is given learning more about the partner institutions and the cultural aspects of the partner cities.

In conclusion, BRoTHER represents a unique network of biobanks in Bavaria and the Czech Republic, which is specialised in exchange of biobank know-how and dissemination of the biobank idea. We are developing specific strategies to bring the biobank idea near to the public and to interconnect innovative technologies with the biobanking idea. With that, BRoTHER could play a crucial role in connecting biobanks all over Europe and to communicate the relevance of biobanking for the healthcare system within Europe.

Bayerisch-Tschechische Hochschulagentur
Česko-bavorská vysokoškolská agentura
gefördert durch
Bayerisches Staatsministerium der Finanzen, für Landesentwicklung und Heimat

Prof Dr Christoph Brochhausen
Vice Chair of Pathology
Head of the Central Biobank Regensburg
Institute of Pathology
University Regensburg
Franz-Josef-Strauß Allee 11
93053 Regensburg, Germany
Tel: +49 (0) 941 944 6636
christoph.brochhausen@ukr.de

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An update on the medical technology sector

Andrew Davies, Digital Health Lead at ABHI provides an important update on the latest developments in the medical technology sector

Advocating on behalf of the largest sector by employment within Life Sciences[1], HealthTech, the Association of British HealthTech Industries (ABHI) marked its 30th anniversary last year. In that time, our industry has changed significantly, from being product- based, to delivering value-based service solutions and increasingly incorporating new fields of science, utilising data, artificial intelligence (AI), robotics and nanomaterials.

We represent 300 member companies, and as their devices, diagnostics and digital technologies have become increasingly sophisticated, treatment for the likes of cancer and stroke is now quicker and more targeted, supporting improved survival rates and life expectancy.

Yet with the well understood demographic shifts[2] comes a rise in chronic conditions, often perpetuated by diet and lifestyle factors, with increased rates of diabetes and obesity[3], which are now the primary drivers of strain on over-stretched healthcare systems[4]. We must now predict, identify, diagnose and treat patients in a holistic manner and as early as possible to prevent, manage or halt disease progression.

There will always be a role for the hospital, but with the right use of technology, we can start to look at delivering care in alternative environments, such as the home or workplace. Through monitoring and predictive algorithms, we are positioned to manage our own health, with added focus on prevention and protection, thus, alleviating pressures on health systems.

It's not all apps, robots and telemedicine, though. There are currently over 11,000[1] Digital Health employees working in the UK; applying their trade to infrastructure projects, such as hospital and GP information systems. Programmes that will equip services, such as the UK's NHS, to deliver on what is arguably its prize asset:[5] its data. As the world's largest single health-payer system, the NHS has a rich data pool. Large datasets, utilised effectively, mean three things for care: it can be more predictable, more personalised and more precise.

> "The UK invests heavily in research, and rightly so, however, there is much less emphasis on implementation and adoption. ABHI are working to develop networks that promote communication and innovation with a strong direction towards implementation."

This data pool gives us the opportunity to deliver against the four Vs of data[6] (Velocity, Volume, Veracity and Variety). However, this data pool cannot be constructed or utilised without the involvement and agreement of patients. Patient consent to data sharing must be the foundation for any revolution in digital health. We must engage citizens to have an informed public debate on the beneficial uses of health data. This is particularly the case when commercial entities form part of the data cycle. For this reason, ABHI is partnering with relevant organisations to ensure we support the debate on informed patient opt-in.

Research[7,8] suggests that the public does not, in principle, want their health records being shared with commercial organisations and so appropriate regulation around data security is essential. People must trust that their information is being used appropriately. This underpinning principle must be supported by a regulatory framework that encompasses product, service and data regulation. Data protection legislation provides the framework for sharing of data and further guidance has been provided in the code of conduct for HealthTech[9] from the Department of Health and Social

Care. Cloud- based services can help overcome this by providing a route to share anonymised data with entities outside of the consented area. Blockchain/distributed ledgers also have great potential to support sharing of health data, both at an organisational level, but potentially in the future as a basis for personal control of data. And so, whilst GDPR has enshrined the basics of data regulation into law, the sensitivity of health data and its sharing with industry may need further governance to build the trust and reassurance with the public.

Given the complexity of the digital landscape, collaboration is crucial. Developers, researchers, clinicians, users and funders all have a role to play. However, a great idea will remain an idea, if it is not given the necessary support needed to scale through access to capital and the right support to navigate and implement within health systems.

> "There will always be a role for the hospital, but with the right use of technology, we can start to look at delivering care in alternative environments, such as the home or workplace."

The UK invests heavily in research, and rightly so, however, there is much less emphasis on implementation and adoption. ABHI are working to develop networks that promote communication and innovation with a strong direction towards implementation.

There is a role for companies, regulators, patients and providers to come together and design a system of transparency and privacy, that works for everyone. The prospect that digital technologies will make our health system more convenient, more coordinated, and more responsive to consumers' needs is enticing. The opportunity for population health management with a focus on healthy living is even more exciting, with a focus on engaged citizens preventing chronic disease and self-managing conditions. ■

Andrew Davies

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Andrew Davies
Digital Health Lead
Association of British HealthTech Industries (ABHI)
Tel: +44 (0)20 7960 4360
enquiries@abhi.org.uk
www.abhi.org.uk
www.twitter.com/UK_ABHI

Refocusing spin structures with Lorentz transmission electron microscopy

Associate Professor Marco Beleggia from the Technical University of Denmark, explains to us how to refocus spin structures with Lorentz transmission electron microscopy

Manipulating the electron spin for the purpose of using it as information carrier is at the basis of the field of research called spintronics. Compared to electronics, where it is the electron charge that carries information, these new materials bring the promise of faster (higher frequency operation) and more sustainable (lower power consumption) technologies in our daily life.

Exotic spin configurations such as homochiral Néel walls[1] and skyrmions[2] have garnered intense interest recently as basic building blocks of next-generation magnetic-based memory, logic and sensors[3]. These structures are formed when the various driving forces in play find an equilibrium: exchange interaction favours alignment of neighbouring spins, anisotropy favours alignment along specific directions, demagnetization favours configurations that minimise stray fields and the Dzyaloshinskii-Moriya interaction (DMI) favours spins at right angles. The sign of the DMI determines whether the right-hand or the left-hand rule applies in choosing which perpendicular, hence the connection with chirality.

In magnetic materials where the preferred direction of magnetization is orthogonal to the plane of the film and where DMI plays a role, the exchange and DMI energy terms favour Bloch and Néel walls, respectively, while minimisation of stray fields leads to flux-closed configurations akin to a toroidal solenoid. The competition between these energies leads to complex domain walls that cannot be described as fully Bloch or Néel[4] and plays an essential role in their dynamical response to applied fields and currents. Understanding this balance is crucial for the development of spintronic devices based on chiral domain walls.

The first step in learning how to control spin structures is to visualise them, observe how they respond to external stimuli and assess the relative strength of the various energy terms. Several magnetic imaging techniques are available for this purpose. For example, X-ray resonant magnetic scattering, nitrogen-vacancy magnetometry and spin-polarized scanning tunneling microscopy. However, most techniques are restricted to deduce the domain wall structure from surface states and due to spatial resolution limitations, often fail to measure precisely the wall width, which would provide access to the strength of the exchange energy.

A technique called Lorentz transmission electron microscopy (LTEM) is a classic tool to study magnetism[5]. It has been successfully applied to understand the local spin order in materials that host skyrmions[2] and other chiral spin structures. LTEM is based on the deflection that electrons experience as they traverse a magnetic sample as a result of the Lorentz force. Since beam electrons fly past a sample at near-light speed, these deflections are tiny. To have any chance of measuring an effect, we need to allow the deflected electrons to travel a large distance by moving the detector well below the sample and take a picture of them only then. This is the concept of "defocus": the more out of focus we are, the more contrast we have in the image. However, as anyone who has taken a badly focused picture with a standard camera can confirm, a defocused image is blurred to the point where the features we want to capture are no longer discernible. This is the conundrum of LTEM, we add defocus because without it we see nothing but the more defocus we add, the less clearly we see the features we are interested in.

The results of a collaboration between Brookhaven National Laboratory, the University of Singapore and the Technical University of Denmark, recently published in Physical Review Letters[6], demonstrate how to overcome the intrinsic limitations of LTEM and quantify to high accuracy a critical parameter of spin structures forming in CoPd multilayers: the Bloch/Néel mixed-character angle η defined as the thickness-averaged angle of the plane where spins rotate as they transition from the "up" to the "down" state.

The key finding in this article is a recipe for data analysis that takes as

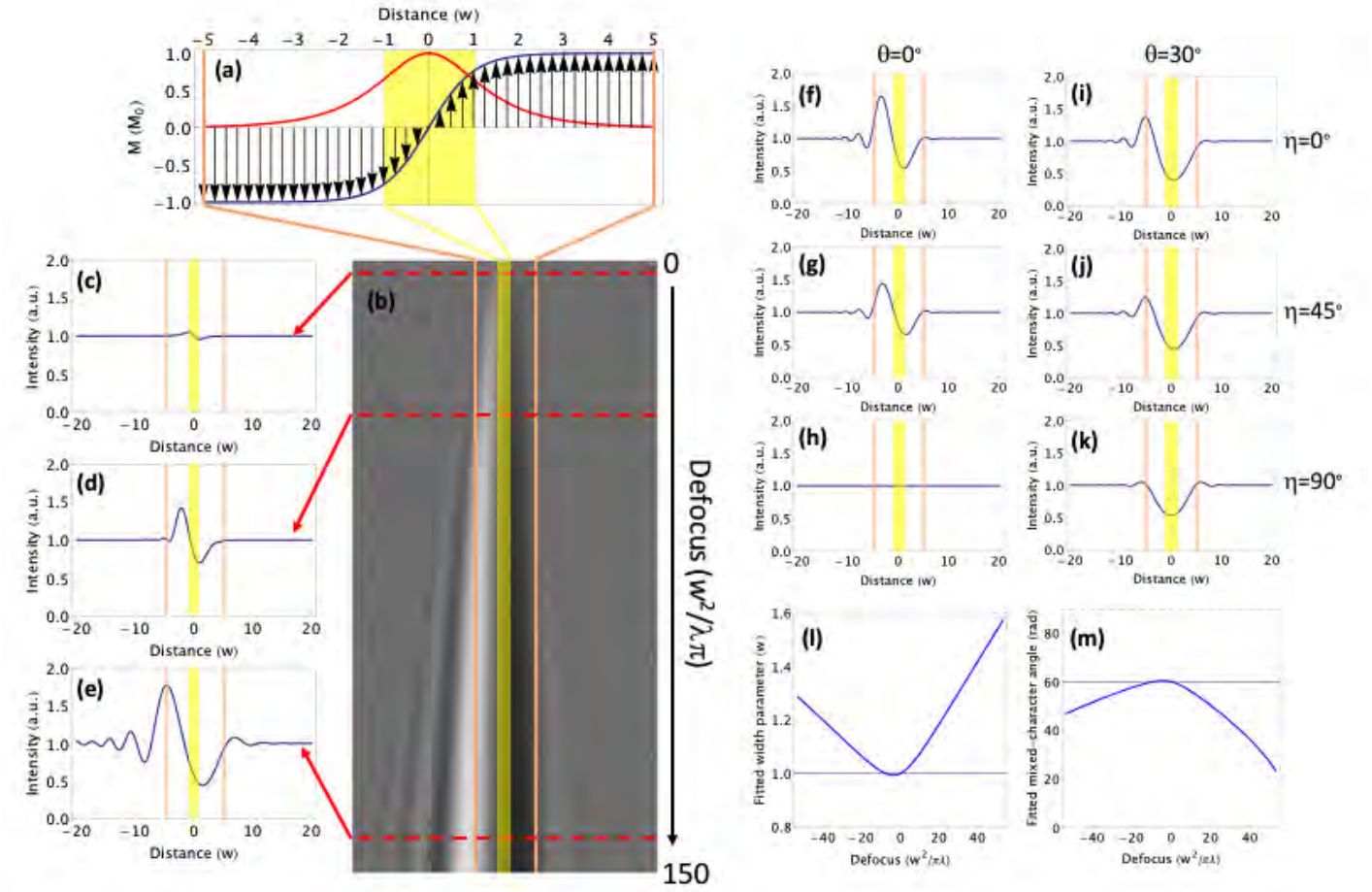

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Figure 1: (a) Sketch of the magnetization components (M_z, blue curve and arrows; M_y, red curve) across a Bloch-type domain wall that develops along the x-axis over a characteristic length w (the wall width); throughout the figure, the yellow box and orange lines indicate length intervals of 2w and 10w, respectively and are shown to illustrate the scale of the information spread with defocus. (b) Simulated intensities observed in LTEM as a function of defocus measured in units of $w^2/\lambda\pi$; for a w=10 nm Bloch wall, the largest defocus of 150 simulated here corresponds to 2 mm for 200 keV electrons. (c-e) Intensity profiles at very low defocus (c), where the domain wall is not significantly blurred but the signal is vanishingly small; intermediate defocus (d), where the wall appears broadened and the signal is higher; large defocus (e), where the signal is further enhanced but the domain wall appears broadened to almost 5x its size. (f-k) LTEM intensities for hybrid domain walls with varying mixed-character angles (rows) and observed at varying sample tilt angles (columns); note (h) with vanishing contrast, as a pure Néel wall is invisible at zero tilt. (l,m) Calibration curves for the domain wall width (l) and the mixed-character angle (m) that are used to determine the "true" values of the parameters w and η by extrapolation to zero defocus. See reference [6] for further details and for an application of this methodology to a CoPd multilayer system where the Bloch/Néel mixed-character angle was measured as η=56°±5°.

input a set of heavily blurred defocus images of a hybrid Bloch/Néel domain wall, where the wall appears enlarged and η may appear under- or over-estimated and produces as output the "true" values of the domain wall width and the mixed-character angle. This new algorithm relies on image simulations carried out with the full Fresnel propagator in a wave-optical framework that includes interference and diffraction effects. As a result, we are no longer forced to choose between images that are either blurry and contrasted (large defocus) or sharp but noisy (small defocus). We have learned how to refocus spin structures with LTEM.

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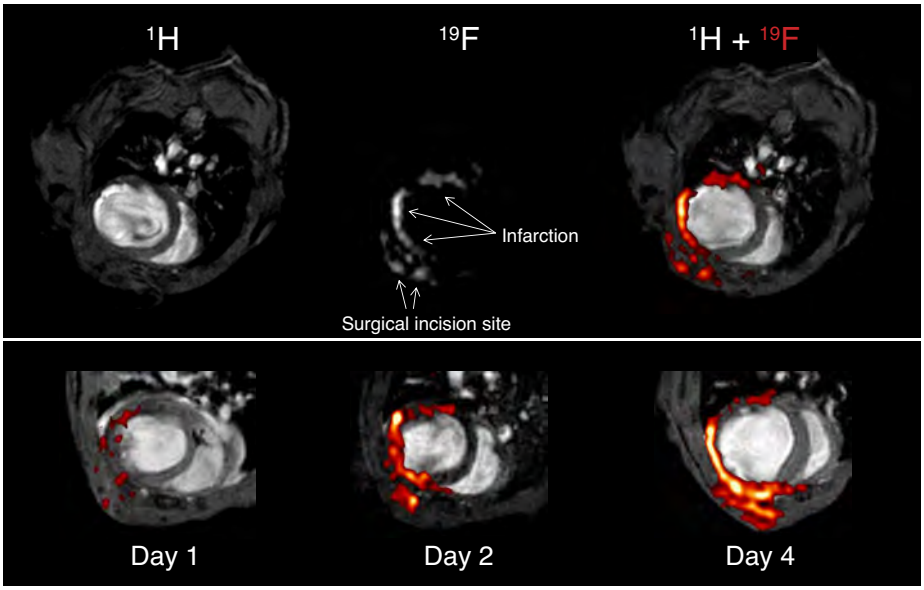
DTU Nanolab
National Centre for Nano Fabrication and Characterization

Associate Professor Marco Beleggia
Head of Electron Matter Interaction
DTU Nanolab
Technical University of Denmark
Tel: +45 4525 3147
cenmb@dtu.dk
www.nanolab.dtu.dk

Cardiovascular magnetic resonance imaging and spectroscopy

Transcending morphology, magnetic resonance techniques can be utilised to shed light on processes on the molecular level to unveil pathological alterations preceding anatomical and functional manifestations of (cardiovascular) diseases, in the view of Ulrich Flögel from Heinrich Heine University Düsseldorf, Germany

Today, magnetic resonance imaging (MRI) is undoubtedly the leading technique in diagnostic imaging. It has attracted a great deal of interest because of its unique combination of qualities. MRI uses non-ionizing radiation, which is harmless to human tissue, offers very high image quality with excellent anatomical details and additionally is capable of providing not only functional but also metabolic information. On the negative side, it was conventionally argued that MRI suffers from low sensitivity compared to other imaging modalities. However, a new generation of nanotechnology-based contrast agents is making it possible to overcome this limitation and bring MRI into the molecular imaging category.



In this context, fluorine (^{19}F) MRI has lately garnered significant scientific interest in the biomedical research community, due to the unique properties of fluorinated materials and the ^{19}F nucleus. The stable fluorine isotope ^{19}F naturally occurs to 100% and exhibits an intrinsic sensitivity for MRI close to that of the ^{1}H nucleus, which is commonly used to produce detailed images of the inside of the body as has been addressed recently. There is negligible endogenous ^{19}F in the body and, thus, no background signal which allows the detection of fluorinated materials as 'hotspots' by combined ^{1}H/^{19}F MRI and renders fluorine-containing molecules as ideal tracers for a wide variety of MRI applications. Importantly, there is a family of compounds – perfluorocarbons – which exhibits a very high fluorine payload and is biochemically and physiologically inert (e.g. Teflon).

However, perfluorocarbons are not mixible with water, therefore they have to be dispersed in water by use of an emulsifying agent leading to biologically applicable perfluorocarbon nanoemulsions (PFCs). Of note, some of those emulsions containing perfluorodecalin, perfluorotripropylamine, perfluorodichloroctane and perfluorooctyl bromide (also known as perflubron or Oxygent®) were already used in patients as artificial blood substitutes.

The recent application of those PFCs for molecular imaging takes advantage of the fact, that after intravenous administration an efficient and selective uptake of PFCs by circulating cells of the innate immune system, in particular monocytes and macrophages, takes place. The subsequent migration of the ^{19}F-loaded, immunocompetent cells into inflammatory foci then permits the unambiguous *in vivo* identification of affected regions by combination of ^{1}H and ^{19}F MRI. This is illustrated in a murine model of myocardial infarction induced by occlusion of a coronary artery – a procedure well known to be associated

with an acute inflammatory response in the affected tissue.

The upper row demonstrates the principle of the combined $^{1}H/^{19}F$ MRI approach: The end-diastolic ^{1}H image (left) clearly shows the presence of ventricular dilatation and wall thinning within the infarcted area of the heart and in the corresponding ^{19}F image (middle), the signal pattern matches the shape of the free left ventricular wall. For merging of the original grayscale images, a hot iron lookup table is applied to the fluorine data, which allows convenient discrimination of the signals from the ^{1}H and ^{19}F nucleus. The resulting overlay (right) confirms the localisation of PFCs within the anterior, lateral and posterior walls. Furthermore, ^{19}F signal is also detected in the adjacent chest tissue, where thoracotomy for the surgical intervention was performed. Note that otherwise no background ^{19}F signal from other tissue is present.

Repetitive measurements from day one after ligation of the coronary artery reveal a time-dependent accumulation of PFCs within the infarcted region as shown in the lower row. The end-diastolic ^{1}H images acquired one, two and four days after induction of myocardial infarction show the progressive left ventricular dilatation as a consequence of the insult. Merging with the matching ^{19}F images (red) demonstrates the successive infiltration of PFCs into the affected area of the heart and the region of the chest injured by surgery. Detected ^{19}F signals are restricted to the area near the infarcted region of the heart; at no time infiltrating PFCs are observed within the unimpaired septum.

> "...in the near future, this exciting emerging field of ^{19}F MRI has the potential to revolutionise imaging-based cell tracking, imaging of disease and its subsequent therapy."

This suggests that not only is it possible to clearly detect specific areas of inflammation, but it is also feasible to assess the severity of inflammation damage. Thereby, the described approach offers a wide range of therapeutic potential: a better understanding of the degree of inflammation in multiple disease conditions would hugely benefit individuals, providing an opportunity to offer timely patient-specific therapy and the capability to monitor treatment regimes.

Forging the way ahead, active targeting of PFCs – by decoration of the particle surface with ligands binding to specific epitopes – can be exploited to visualise other clinically relevant structures including blood clots and different cell types. By attaching distinct ligands for different targets to individual PFCs that each has its own specific MRI signature, this will allow the concurrent visualisation of several danger signals within one MR session. Here, the ultimate goal will be to advance the ^{19}F probes for *in vivo* visualisation of biomolecular processes, which proceed alterations at the anatomical and organ level and to enable early patient-specific precision therapy.

Finally, in terms of a theranostic approach, targeted PFCs could additionally be doped with distinct drugs, which will enable, by directing those PFCs to a specific danger pattern, its concurrent treatment. Since ligands and targets can be easily adapted to a variety of problems, this approach provides a general and versatile platform for molecular imaging which strongly extends the frontiers of MRI. Thus, in the near future, this exciting emerging field of ^{19}F MRI has the potential to revolutionise imaging-based cell tracking, imaging of disease and its subsequent therapy.

HEINRICH HEINE
UNIVERSITÄT DÜSSELDORF

Ulrich Flögel
Professor of Experimental Cardiovascular Imaging
Heinrich Heine University Düsseldorf
Germany
Tel: +49 211 8110187
floegel@uni-duesseldorf.de
www.nmr.hhu.de

Assessing nanomaterials health risks in the workplace

Cecilia Van Cauwenberghe from Frost & Sullivan's TechVision Group assesses nanomaterials health risks in the workplace, starting with an overall perspective on the topic that includes risk assessment policies

Nanomaterials can be grouped following the directives of the European Center for Ecotoxicology and Toxicology of Chemicals (ECETOC) Task Force on Nanomaterials. Such a comprehensive concept for the grouping and testing of nanomaterials was denominated as DF4nanoGrouping (Gupta et al., 2018). This assessment framework assigns nanomaterials to four main groups (MG) as follows: soluble nanomaterials (MG1), biopersistent high aspect ratio nanomaterials (MG2), passive nanomaterials (MG3) and active nanomaterials (MG4) (Liu et al., 2019). Concomitantly, in order to make this characterisation consistent, DF4nanoGrouping considers material properties as follows: intrinsic properties in Tier 1, comprising water solubility, particle morphology and chemical composition; system-dependent properties in Tier 2, including dissolution in biological media, surface reactivity, particle dispersibility and in vitro effects; testing properties, in Tier 3, comprehending non-animal testing confirmed or corrected using data from short-term in vivo studies (Bianchi et al., 2019).

Exposure in the workplace

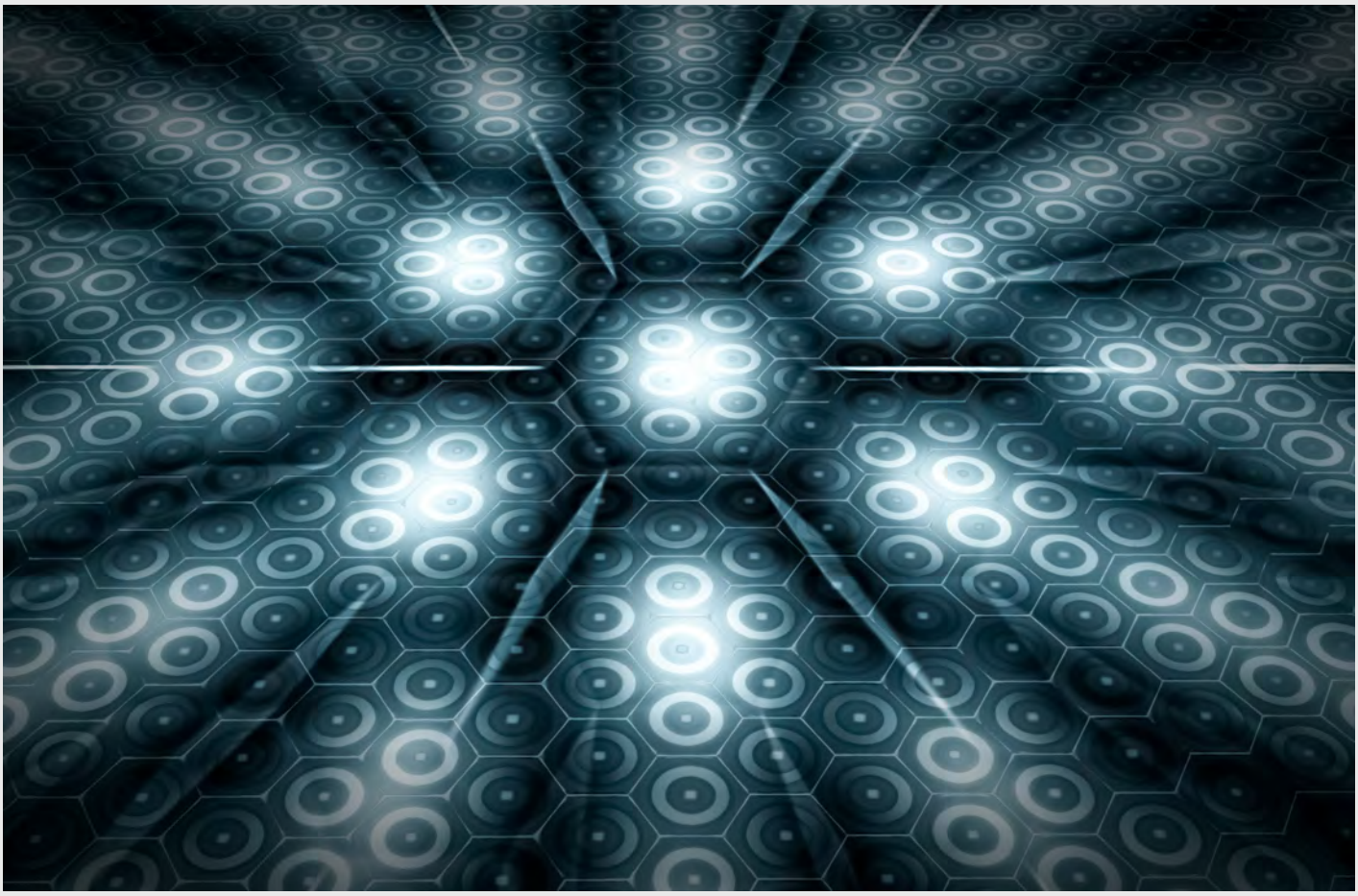
Engineered nanoparticles can be exogenously ingested from hand-to-mouth contact at the workplace. Whereas larger particles of 5–30 µm are usually placed in the nasopharyngeal region, smaller particles of 1–5 µm are dropped in the tracheobronchial region. Once ingested or inhaled, particles may be further absorbed or removed by mucociliary clearance. If absorbed, nanoparticles can penetrate and travel into the gastrointestinal (GI) tract. Submicron particles of less than 1 µm and nanoparticles of 100 nm can penetrate into the alveolar region, from where they cannot be removed.

Moreover, once in close contact with the alveolar epithelium soluble nanoparticles can penetrate other tissues and trigger particle–cell interactions, cross the blood–air–tissue barrier and enter the bloodstream, thereby potentially reaching other target organs. On the other hand, insoluble nanoparticles may prolong their residence in the lung leading to injury and immune responses, as well as serving as cleavage for tumour cells (Keller and Parker., 2019). Therefore, typical exposure to nanomaterials at the workplace is deeply related to a broad spectrum of both acute and chronic effects, including inflammation, asthma, cystic fibrosis, lung diseases and cancer. Neurotoxicity represents another health risk. Inhaled nanoparticles inside the olfactory mucosa may translocate in the central nervous system (CNS).

"Nanomaterials present various severe health risks for people handling them. The effective and safe management of health hazards associated with the manipulation of engineered nanoparticles must consider the nanomaterial route from manufacturing and distribution to storage and final disposal. Europe is advancing toward the institution of effective policies that strive for a more cautious manipulation of engineered nanomaterials at the stages of manufacturing, use and recycling."

Final disposal considerations

The generation of nanomaterial waste is difficult to assess. Both effective dilution and proven deactivation are crucial for clean and safe nanomaterials disposal. The three pathways followed for nanomaterials waste disposal are: landfill, thermal treatment and recycling, all of which are strictly dependent on the material type and the overall conditions of the nanomaterials waste. It is important to highlight that material recovery or recycling may involve some lateral risks, such as occupational health effects of recycling processes, the environmental impact associated with the final disposal of the residues and the introduction of residual nanomaterials into recycled products (Resnik, 2019).



Final remarks

Nanomaterials present various severe health risks for people handling them. The effective and safe management of health hazards associated with the manipulation of engineered nanoparticles must consider the nanomaterial route from manufacturing and distribution to storage and final disposal. Europe is advancing toward the institution of effective policies that strive for a more cautious manipulation of engineered nanomaterials at the stages of manufacturing, use and recycling. ■

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Cecilia Van Cauwenberghe, PhD, MSc, BA
Associate Fellow and Senior Industry Analyst
TechVision Group, Frost & Sullivan
cecilia.vancauwenberghe@frost.com
ww2.frost.com
www.twitter.com/Frost_Sullivan

The NanoStreeM Project: Results and Perspectives

Here, Dr Dimiter Prodanov discusses the results and perspectives of NanoStreeM, a consortium which examines occupational safety of nanomaterials

Nanomaterials are fascinating for the wealth of unique properties that they possess, which can be used to improve everyday life. Such desirable characteristics having numerous industrial applications can include increased strength of the nano-enabled material, its chemical reactivity, or altered electrical properties.

It is generally accepted that the recently developed and upcoming variety in nanomaterials will provide challenges for assessing their risks. Therefore, a variety of new risk assessment tools have been developed. Acceptance and use of one or another risk assessment framework can have a wide range of economic and safety repercussions, therefore it is of considerable science policy interest. For example, in the European Union, nanosafety research has been supported throughout the last 3 EU Framework Programmes. Whereas only five nanosafety projects were funded in the 6th Framework Programme, around 50 projects and initiatives on nanosafety were funded in the 7th Framework Programme, between 2007 and 2013. By 2018, 19 projects had been funded under H2020. In the USA, the National Institute of Occupational Safety and Health (NIOSH) is the leading federal agency conducting research and providing guidance on the occupational safety and health implications and applications of nanotechnology. International regulatory science efforts are coordinated by the Organisation for Economic Co-operation and Development (OECD). On the other hand, it should be noted that partially because of this vigorous science policy interest, the number of publications dealing with the toxicology of nanomaterials has increased tremendously, although most studies are not directly applicable in the industrial setting for risk assessment of Engineered Nanomaterials (ENMs).

ENMs are used in a wide variety of consumer products: from cosmetics and paints to sportswear, mobile phones, computer chips, and batteries. Such materials represent bottom-up nanotechnology, where particles, fibres or surfaces are synthesized from molecules. In contrast, top-down nanotechnology can be exemplified by semiconductor processing, where nano-scale features are patterned with exceptional precision on macroscopic objects. In the concrete case of the semiconductor industry, the chipmakers are using a growing variety of materials, as companies seek to further improve devices' performance to meet increasing market demand in a constant process of innovation. At present, there are more than 200 chemical compounds consisting of elements, such as silicon, germanium, copper, gold, hafnium, indium and many others, which are present in most computer and mobile phone chips. In some manufacturing processes, ENMs enable superior yields and performance. Other examples include solar cell industry and energy storage, where a number of diverse materials based on rare elements are used. Every one of these applications requires unique expert insight into possible consumer, occupational or environmental hazards.

> "...it is important to identify appropriate sources of information and communication channels for all actors along the supply chain, including the general public."

The NanoStreeM consortium has taken up the challenge in defining a road map of occupational safety of nanomaterials in nanoelectronics where we have identified the existing gaps in our knowledge and formulated a number of recommendations for their mitigation. Definite needs for competencies development were established in terms of informing about the physicochemical properties of nanomaterials, a dedicated nanotoxicology knowledge base, and about the limitations of the traditional occupational chemical risk assessment. To meet these needs, the project composed nanosafety training packages, as one of its major outcomes. The project partners Tyndall, The French Alternative Energies and Atomic Energy Commission (CEA), and Imec composed three dedicated training courses focusing on semiconductor industry processes and the

Final NanoStreeM consortium meeting at ST-Crolles, Crolles, 9 Oct 2018

cleanroom environment. Developed training packages will be used by the semiconductor industry and the partnering institutions after the end of the project.

Assessment of the risks, related to nanotechnology innovation, requires an integrated multidisciplinary approach due to the complexity of the interactions on the nanoscale. On the other hand, the safety of nanomaterials and nanotechnology cannot be considered on a case-by-case basis. A systematic framework for risk governance should be centred on generic principles, such as Safe by Design. Conversely, concrete implementations of such principles can be sector-specific. In the engineering context, Safe by Design can be implemented in the integration of hazard identification and risk assessment methods early in the design process to eliminate or minimise the risks of harm throughout the construction and life of the product being designed. Safe by Design includes three components: safe design, safe production, and safe use. In the context of the semiconductor industry "safe design" translates to development of processes, where the used nanoparticles have known hazards. "Safe production" entails a reduction of process hazards at identified hotspots of risk. "Safe use" ought to consider issues, related to recycling and end-of-life. Such knowledge then may be used to inform design choices.

The NanoStreeM project demonstrated that the nanoparticle emissions in normal operation mode of cleanroom processing tools are not likely to occur. Therefore, future studies in the semiconductor industry should focus on the assessment of the environmental impact, product end-of-life, and recovery of valuable elements through recycling. Finally, the NanoStreeM project has identified some key challenges and data gaps, which the industry is facing. On the first place, it is the lack of reliable data on nanoform toxicity. Persistence of such gap inadvertently leads to uncertainty in regulations. Therefore, it is necessary to identify how much uncertainty is acceptable in terms of cost and impact. Secondly, risk assessment methods for nanomaterials are far from mature, which makes their application very difficult in an industrial setting. Therefore, innovation guided by the Safe By Design principle must be aided by ongoing and future regulatory research. Finally, it is important to identify appropriate sources of information and communication channels for all actors along the supply chain, including the general public.

Acknowledgment

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NANOSTREEM

Dr Dimiter Prodanov
IMEC vzw
Tel: +32 162 818 40
dimiter.prodanov@imec.be
http://www.nanostreem.eu/

Finland's priorities in science policy

Hanna Kosonen, Minister of Science and Culture, Finland, details Finland's priorities in science policy

In a socially, economically and ecologically sustainable society, the economy is managed for the people, not the other way round. Sustainable economic growth is built on a high rate of employment and strong public finances and the Finnish government rates education and research very highly. Education and culture are an important part of our Finnish and European value systems and are important and necessary means of guaranteeing individual freedoms.

In the future, our citizens' wellbeing will continue to draw on knowledge and skills and work and entrepreneurship. Our challenge and goal in Finland is to keep our level of education and competence at an excellent level and even back to the top of the world league. We want to create the best possible conditions for the best working life in the world. We want to be a nation with happy and competent professionals where every person's knowledge and skills are put to good use.

Our stated goal is that by 2030, the Finnish public and private sectors together will invest 4% of the GDP in research and innovation activities in an effective and profitable manner. These investments will improve, for their part, the wellbeing of the population and society. Working together for this, both in Finland and abroad, is our duty and a strength.

Higher education in Finland is provided by the universities and the universities of applied sciences. Both sectors have their own profiles. Universities emphasise scientific research and instruction, whereas universities of applied sciences adopt a more practical approach. However, all higher education institutions are autonomous in organising their instruction and academic year. Entry to higher education is based on student selection with a healthy competition of many applicants. Higher education institutions use various student selection criteria. Most commonly these include success in matriculation examination and entrance tests. Equal access to higher education is ensured by a wide institutional network, free education, student financial aid, as well as through flexible pathways to higher education. Efforts have also been made to lower the threshold to apply to higher education by developing an on-line joint application system.

> "It is now a global trend to use digital and open approach methods to generate high-standard research faster and more effectively. The objective of science policy is to raise the international standard as well as the knowledge and competence base of Finnish science and to increase the innovation capacity in the national economy, to bolster the research infrastructure and safeguard the openness of research and science."

Institutions of higher education aim to improve the quality of education by revamping education content, teaching methods, learning environments and the competence of teachers, as well as to increase cooperation. The institutions need to make full use of the possibilities offered by digitalisation. They develop their student admissions, procedures for the recognition of prior learning and degree programmes in order to step up national and international mobility.

The objective of Finland's higher education policy is to develop higher education institutions as an internationally competitive entity where each institution also flexibly responds to regional needs. The activities of universities and universities of applied sciences promote Finnish competitiveness, well-being, education and learning as well as sustainable development. Cooperation and transparency are the key drivers for research and innovation. We need more coherent RDI

Hanna Kosonen, Minister of Science and Culture, Finland

policies and further support for the building of internationally attractive knowledge clusters and innovation systems which, in turn, will help us achieve our ambitious 4% goal. Using shared approaches and legislative means to strengthen open research and innovation will be crucial in the near future.

Science policy helps channel competence into forms such as information, knowledge, processes, products and services. Science policy is also inherently linked to innovation policy and it supports knowledge production. It also enhances the competence level of citizens and the nation in collaboration with different stakeholders to make research carried out in Finland more visible, international and effective. The purpose of science policy is to ensure that the organisations that carry out research can engage in research in a way and to a standard that is typical of highly competitive international science communities. Science policy also helps make researched information easily available for widespread use in society.

It is now a global trend to use digital and open approach methods to generate high-standard research faster and more effectively. The objective of science policy is to raise the international standard as well as the knowledge and competence base of Finnish science and to increase the innovation capacity in the national economy, to bolster the research infrastructure and safeguard the openness of research and science.

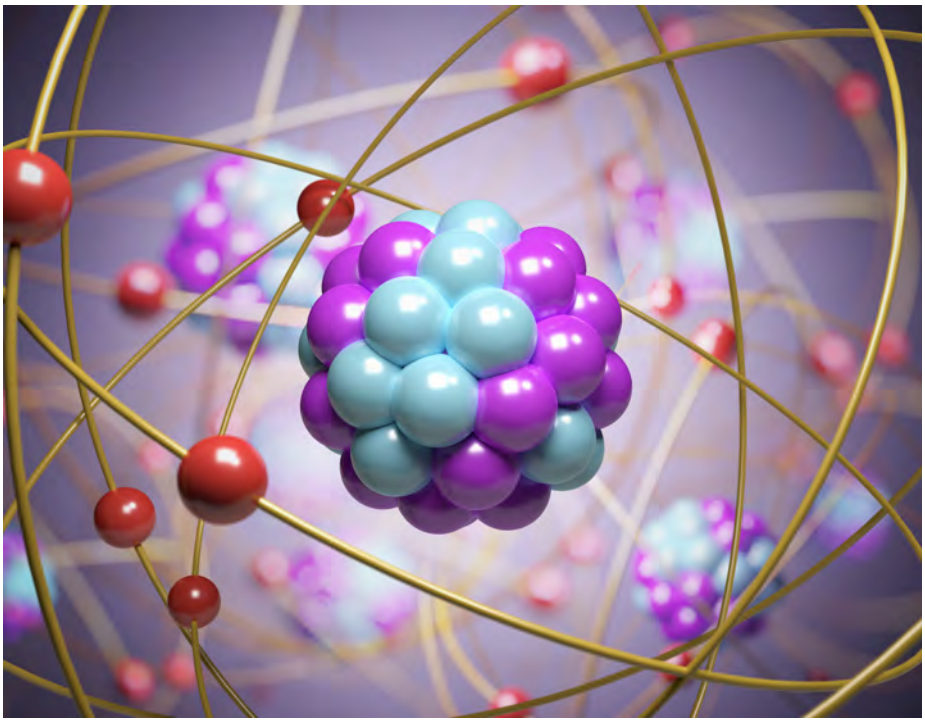
The openness of science and widespread use of information in society are important aspects as science and research have an important role also in Finland in solving the world's wicked problems from climate change to other threats to planetary and human well-being that all need urgent solutions. ■

Hanna Kosonen
Minister of Science and Culture, Finland
The Ministry of Education and Culture
Finnish Government
Tel: + 358 295 16001
kirjaamo@minedu.fi
https://minedu.fi/en/frontpage
https://valtioneuvosto.fi/en/rinne/minister-of-science-and-culture
www.twitter.com/okmfi
www.twitter.com/kosonenhanna

Finland: Research on subatomic physics

Here, Professor Katri Huitu discusses the Helsinki Institute of Physics' role in Finnish research of subatomic physics

Experimental research of subatomic physics involves notoriously many aspects of physics, technology, industry, and also finances and management. Organising top national research and always scarce economic resources to produce world class results from work with leading global research laboratories, such as CERN, the European Organization for Nuclear Research, in Geneva, Switzerland with more than 13000 global users, is a major undertaking. In Finland this work is done by Helsinki Institute of Physics (HIP), which successfully coordinates research with CERN and contributions to FAIR, the Facility for Antiproton and Ion Research, currently constructed in Darmstadt, Germany.



HIP – national priorities and agile execution

HIP is a national institute and organisation operated by five major Finnish universities in geographically separate cities: Helsinki, Jyväskylä, Espoo, Tampere and Lappeenranta. In addition, the Radiation and Nuclear Safety Authority (STUK, Helsinki) is an interim member since 2018.

The extensive expertise related to accelerator research from all involved institutes is fully utilised in the close collaboration with leading international accelerator centres CERN and FAIR. HIP currently covers a continuum of research topics from theoretical physics, analyses of accelerator experiments, experimental setups and instrumentation, as well as technology development all the way to the commercialisation of products in collaboration with technology industries.

All research in HIP since its foundation in 1996 is organised in fixed term projects which ensures renewal of research. Projects are counterbalanced by CERN experiments that require longer term commitment. Current research activities of HIP are organed in four programmes, which in turn consist of several 3-year projects. Decisions of programmes and projects are done by HIP Board representing member universities and personnel. Board decides also use of funding for the programmes. Scientific expertise for these decisions comes from an influential Scientific Advisory Board, which annually evaluates the performance of the Institute in a two-day visit and gives recommendations on how to proceed.

HIP research programmes – from theory to experiments to technology

Currently the main research focus of HIP is on three of the CERN LHC experiments: ALICE, CMS and TOTEM, where Finnish scientists contribute significantly to ultra-relativistic heavy ion physics, new physics searches, standard model measurements and forward physics. The full physics exploitation of these, including the preparation of their high luminosity phase, constitute the highest priority

of the Finnish high-energy physics community. Computing and data access are an integral part of this physics exploitation. HIP participates in the Worldwide LHC Computing Grid through the Nordic and the HIP centers.

Participation in instrumentation is a prerequisite in experimental particle physics for accessing scientific data and for producing new physics. HIP Detector Laboratory for high-quality instrumentation is an essential infrastructure for successful participation in high energy physics experiments. HIP is also involved in other CERN experimental activities, such as ISOLDE, which provides radioactive ion-beams, and CLOUD setup, where climate change can be studied in a controllable laboratory environment. HIP is also actively contributing to two conceptually different designs of the next generation CERN particle colliders, compact linear electron-positron collider (CLIC) and future circular collider (FCC).

Since 2010 HIP has participated in construction of FAIR, the first priority international facility in the nuclear physics community research in Europe. FAIR will provide unique experimental opportunities with antiproton and relativistic heavy-ion beams as well as secondary radioactive ion beams for a broad range of studies in atomic and plasma physics, hadron and nuclear physics and in astrophysics. At the moment Finnish priority is the FAIR NUSTAR experiment. HIP group is involved in the FAIR phase-0 experiments that will start soon and the FAIR facility should be in full use for physics by 2026.

Researchers of the successful HIP theory programme work e.g. on extensions of the Standard Model (SM) of particle physics. The SM is among the most precise theories of physics but eventually needs to be extended – the fact that galaxies do not disintegrate requires that so-called Dark Matter increases their gravitational pull. Dark Matter is not part of the Standard Model. HIP theorists scrutinise the SM in various ways and suggest ways to test it. In addition to accelerators, tests include satellite missions, dark matter experiments, and gravitational wave experiments such as European Space Agency's (ESA) future gravitational wave satellite mission LISA. The quality of the theory programme is demonstrated by the fact that currently two of the five theory project leaders have an ERC grant.

The accelerated expansion of the Universe also requires beyond the SM explanations. HIP personnel participate in ESA's Euclid satellite mission, which will be one of the most important cosmology missions for the next decade. Further synergies with ESA are sought in relation to the harsh radiation environments operations. Technological aspects of radiation safety are developed in close collaboration with STUK. HIP also collaborates closely with Business Finland, the Finnish agency for supporting and funding innovations, with focus on CERN-related new business ideas. Technology related activities seek active partnerships from industry and improve connections of Finnish companies to CERN and FAIR.

Tightly connected to the HIP CMS group, HIP's Open Data and Education is a showcase project for Open Science, where huge amounts of data from CERN is made available for wider use in the scientific community and for school education. The HIP project is in a pivotal role and has given courses for several years to high school teachers on use of open data in education. The project also organises High School visits to CERN: since 2000 almost 5400 students from close to 400 schools have visited CERN. HIP Detector Laboratory also provides hands-on education on instrumentation. These kind of outreach activities are an integral part of HIP.

Boosting HIP community spirit

The geographically and scientifically extended research programme of HIP has a risk to lose focus of research and the activities become scattered. In order not to overlook common goals, meetings of the whole HIP community are indispensable. A focal point of internal communication in near future is on communications via various information channels, personnel activities in wellbeing groups of member institutions, and organisation of meetings for the whole community.

Enthusiastic personnel doing world class research will keep Finland's contribution to accelerator related physics strong in the future!

HELSINKI INSTITUTE OF PHYSICS

Professor Katri Huitu
Director
Helsinki Institute of Physics
Tel: +358 2 941 50520
katri.huitu@helsinki.fi
www.twitter.com/HIPhysics
https://www.hip.fi/

Ground state negative ion formation in complex heavy systems: Electron affinity determination

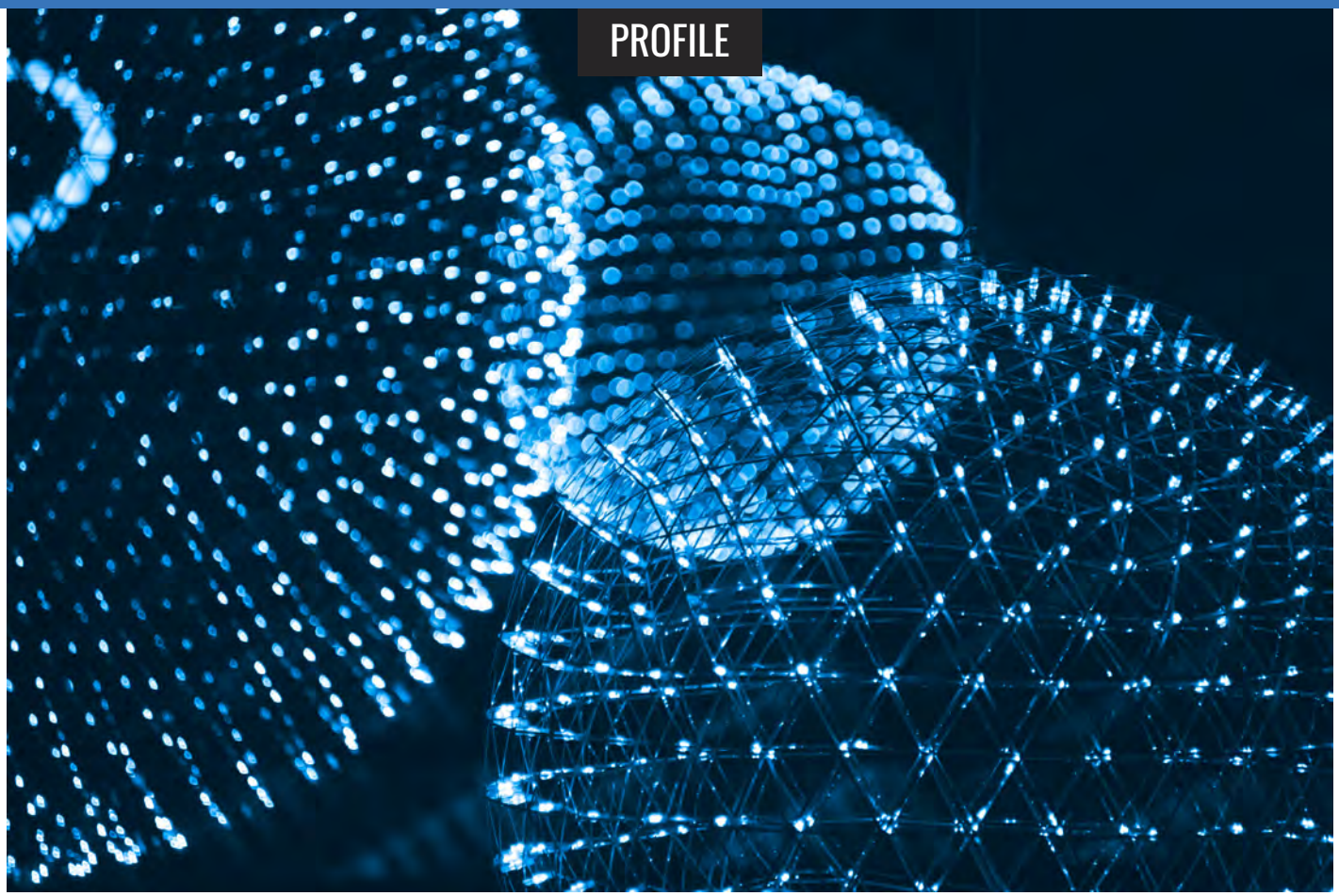
Dr Alfred Msezane from the Department of Physics, Clark Atlanta University,
explains ground state negative ion formation in complex heavy systems, including comment on electron affinity determination

We begin with the discussion of the ground state negative ion formation in low-energy electron collisions with complex heavy systems, such as the lanthanide and actinide atoms, as well as the fullerene molecules. The knowledge gained is essential for the determination of unambiguous and reliable electron affinities (EAs) for these systems. Generally, the low-energy electron elastic scattering total cross sections (TCSs) for complex heavy systems are characterised by Ramsauer-Townsend (R-T) minima, shape resonances and dramatically sharp resonances representing ground, metastable and excited negative ion formation. The energy position of the sharp resonance appearing at the second R-T minimum of the ground state TCS represents the anionic binding energy (BE) of the formed ground state negative ion during the collision. This BE has been identified with the theoretically challenging to calculate electron affinity of the considered complex heavy system. Indeed, the delineation and identification of the resonance structures in the TCSs are essential for the correct interpretation of the calculated results and the determination of unambiguous and reliable EAs of the complex heavy systems.

II.1 Overview

For most of the lanthanide atoms, producing sufficient anions with known anionic BEs that can be used in photodetachment experiments is very challenging; for the actinide atoms, the situation is even worse. Due to their radioactive nature, they are difficult to handle experimentally. Theoretically, the large number of electrons involved and the presence of open d- and f-subshell electrons in both the lanthanide and actinide atoms, results in many intricate and diverse electron configurations. These lead to the computational complexity of the electronic structure calculation, making it very difficult to obtain unambiguous and reliable EAs for these systems using structure-based theoretical methods. These are notorious for their slow convergence. Indeed, many existing experimental measurements and sophisticated theoretical calculations have considered the anionic BEs of the stable metastable and/or excited negative ion formation to correspond to the EAs of the considered lanthanide and actinide atoms. This is contrary to the usual meaning of the EAs found in the standard measurement of the EAs of such complex systems as atomic Au, Pt and most recently At as well as of the fullerene molecules, from C_{20} through C_{92}. In these systems, the EAs correspond to the ground state BEs of the formed negative ions. In the electron interactions with fullerene and fullerene-like systems, simple model potentials are widely used to describe the C_{60} and other fullerene shells. At the heart of these model potentials are the two experimentally determined parameters, namely the fullerene radius and its EA. The lack of the appropriate parameters for other fullerene molecules is the main reason for the struggle by existing theoretical calculations to go beyond the theoretically simple C_{60} fullerene molecule.

Accurate and reliable atomic and molecular affinities are essential for understanding chemical reactions involving negative ions. And the EA provides a stringent test of theoretical calculations when their results are compared with those from reliable measurements. For the lanthanide atoms, the measured and/or calculated EAs are riddled with uncertainty and full of ambiguity as well. To our knowledge, there are no EA measurements available for the actinide atoms. However, the recent experimental determination with high precision of the BE of the least-bound electron in



atomic No promises measurements of the EA as well. And this presentation will guide the future measurement of the EAs of the actinide atoms through the determination of their ground state negative ion BEs. Then sophisticated theoretical methods such as the Dirac R-matrix, MCHF and RCI can use the BEs of the formed negative ions during the collisions to generate target wave functions and for fine-structure determination.

Recently, our robust Regge-pole methodology achieved a theoretical breakthrough through the identification of the crucial electron-electron correlation effects and the vital core-polarization interaction as the major physical effects mostly responsible for negative ion formation in low-energy electron scattering from complex heavy systems. The novelty and generality of the Regge-pole approach is in the extraction of the anionic BEs from the calculated TCSs of the complex heavy systems; for ground state collisions these BEs yield the unambiguous and reliable theoretically challenging to calculate measured EAs. Very recently, the ground state anionic BEs extracted from our Regge-pole calculated electron elastic TCSs for the fullerene molecules C_{20} through C_{92} have been found to match excellently the measured EAs[1,2]. Also, the agreement between our Regge-pole calculated ground-state anionic BEs and the measured EAs of Au[3] and Pt[3] as well as of C_{60} [4] is outstanding. The Regge-pole method requires no assistance whatsoever from either experiment or other theory for the remarkable feat.

II.2 Lanthanide Atoms

The lanthanide and the Hf atoms provide clear cases of the ambiguous and confusing measured and/or calculated EA values.[5] As examples, for the Eu atom two measurements determined different EA values for its EA, viz. 0.116eV and 1.05eV. These agree excellently with the Regge-pole calculated BEs for the highest anionic excited and the metastable states, respectively; the ground state anionic BE for Eu has been determined recently to be 2.63eV[5]. This BE value should be considered as the EA of the Eu atom. Other examples where the measurements of the EAs correspond to the BEs of the metastable and/or excited states include the lanthanide atoms Tb, Tm, Gd and Yb as well as the Nb and Hf atoms.[5] For Hf the Relativistic Configuration Interaction (RCI) calculated EA agrees excellently with the Regge-pole calculated BE of an excited state and not with that of the ground state. These results demonstrate the importance of obtaining the ground, metastable and excited ionic states BEs. It is noted here that the determination of the ground state negative ion BE of complex heavy systems is a great challenge for the structure-type calculations.

II.3 Actinide Atoms

In[6] the low-energy electron scattering from the actinide atoms Th, Pa, U, Np and Pu was investigated through the elastic TCSs calculations. The objective

was to delineate and identify the characteristic resonance structures as well as to understand and assess the reliability of the existing theoretical EAs. Particularly interesting in the study[6] is the finding for the first time that the TCSs for atomic Pu exhibited fullerene molecular behaviour[1] near- threshold through the TCS of the highest excited state, while maintaining the atomic character through the ground state TCS. Very recently, the low-energy electron scattering TCSs for Cm to Lr actinide atoms were explored. We discovered new manifestations in the TCSs of Cm to Lr actinide atoms; namely, atomic and fullerene molecular behaviour near threshold. We have attributed these peculiar tunable behaviours in the TCSs to size effects impacting significantly the polarization interaction. This provides a novel mechanism of tuning a shape resonance and R-T minimum through the polarization interaction via the size effect. The comparison between the Regge-pole calculated ground, metastable and excited states anionic BEs with the existing theoretical EAs demonstrates that the existing calculations tend to obtain metastable and/or excited states BEs and equate them incorrectly with the EAs. Indeed, this leads to an ambiguous and unreliable determination of the EAs of complex heavy systems; they are already populating the literature.[7] For an unambiguous and a definitive meaning of the EA, we recommend using the ground state anionic BE as the EA of complex heavy systems, consistent with the use in the determination of the EAs of such atoms as Au and Pt as well as of the fullerene molecules.[1,2]

II.4 Fullerene Molecules

For fullerene molecules, excellent measured EAs are available in the literature from C_{20} through C_{92}. Benchmarked on the measured EAs of C_{60} [4], the Regge-pole methodology was used to calculate the ground state anionic BEs of the fullerene molecules negative ions from C_{20} through C_{240}. Our calculated ground state anionic BEs agreed excellently with the available measured EA values of C_{20} through C_{92}. Indeed, these results provided great credence to the ability of the Regge-pole methodology to extract from the calculated TCSs reliable EAs for the fullerene molecules for the first time. The obtained agreement represented an unprecedented accomplishment by the Regge-pole methodology in electron-cluster/fullerene collisions. For the fullerene molecules, other theories are still struggling to go beyond the theoretically simple C_{20} and C_{60} fullerene molecules. It is noted here that the fullerene TCSs are very rich in metastable and excited anionic resonances, revealed for the first time in[1,2]. Thus, careful delineation and identification of the various resonances in the TCSs, particularly for the anionic ground states are essential for reliable calculation of their EAs. These fullerene negative ions could be useful in catalysis.

Indeed, many existing experimental measurements and sophisticated theoretical calculations have considered the anionic BEs of the stable metastable and/or excited negative ion formation to correspond to the EAs of the considered lanthanide and actinide atoms[7]. This is contrary to the usual meaning of the EAs found in the standard measurement of the EAs of such complex systems as atomic Au, Pt and At as well as of the fullerene molecules. In these systems, the EAs correspond to the ground state BEs of the formed negative ions. For fullerenes, existing theories continue to struggle to obtain reliable EAs.

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CLARK ATLANTA UNIVERSITY

Dr Alfred Msezane
Department of Physics,
Clark Atlanta University
Tel: +1 404 880 8663
amsezane@cau.edu
www.cau.edu/department-of-physics/

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Une stratégie commune à long terme pour 2025 en matière de formation, de recherche et d'innovation

Frédérique Vidal, ministre de l'Enseignement supérieur, de la Recherche et de l'Innovation au gouvernement français, explique comment les universités européennes vont définir une stratégie commune et à long terme pour 2025 en matière de formation, de recherche et d'innovation

A l'occasion de son discours sur l'Europe en septembre 2017, le Président de la République française a proposé la création d'universités européennes pour constituer un réseau entre des établissements de plusieurs pays d'Europe et renforcer le sentiment d'appartenance européenne. L'objectif était que ces institutions permettent à chaque étudiant de construire un parcours à l'ambition européenne, en étudiant dans des pays étrangers et en y apprenant au moins un nouvelle langue étrangère. En écho à cette initiative, la Commission européenne a lancé en octobre 2018 le premier appel à projet sur les Universités européennes doté d'un budget de €60 millions nourrissant l'objectif d'en constituer une vingtaine d'ici 2024.

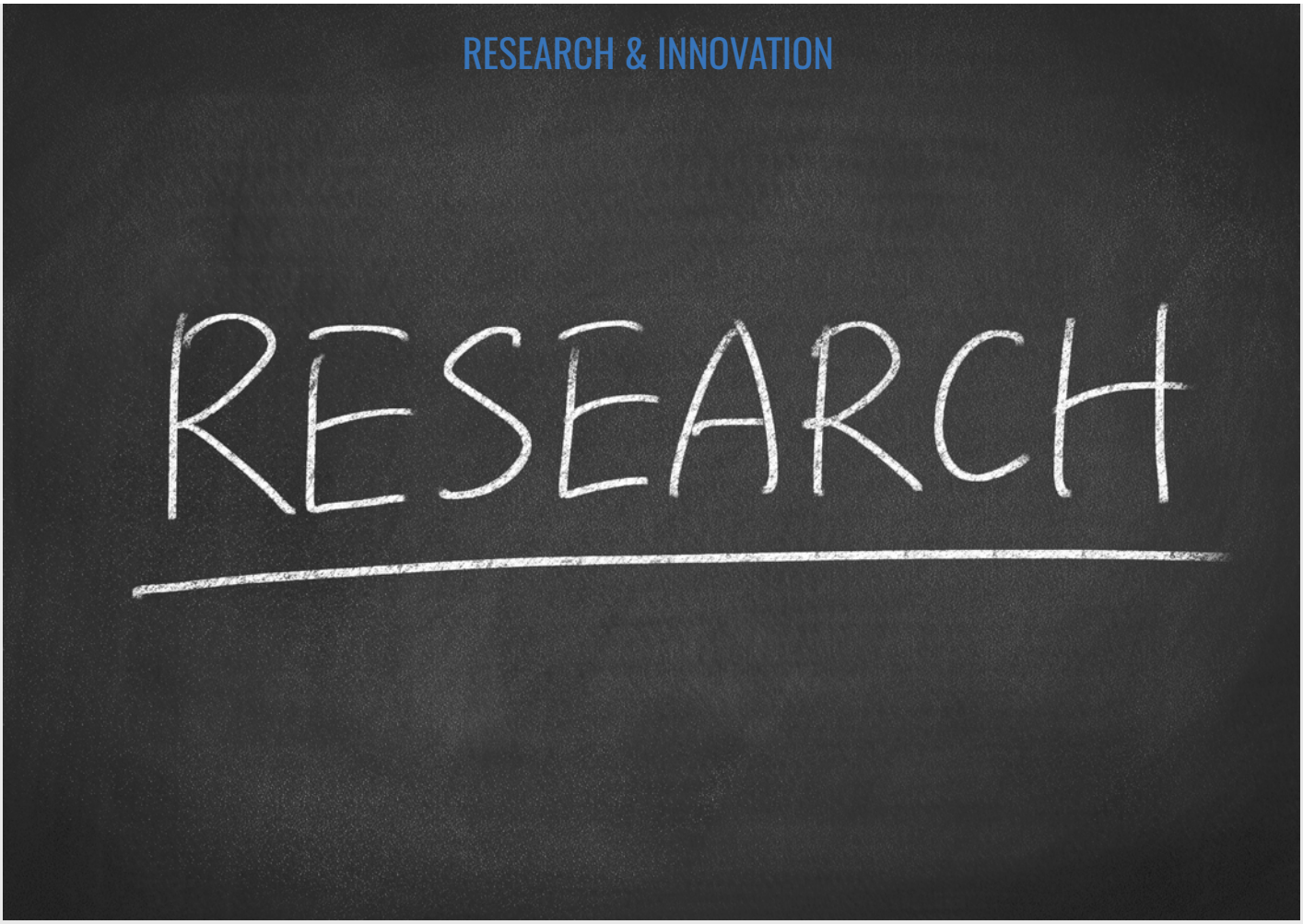
Je suis heureuse et fière que l'engagement français pour la coopération européenne ait permit d'impulser cet engouement au niveau européen, et je tiens à saluer la rapidité avec laquelle la Commission européenne s'est emparée de ce sujet. Au bout de quelques mois seulement, les premiers résultats ont été rendus publics. Sur 54 candidatures reçues, 17 regroupements représentant 114 établissements d'enseignement supérieur de 24 États membres différents ont été sélectionnées.

Parmi elles, ce sont 16 établissements français qui ont été retenus. L'implication des établissements français en faveur des universités européennes ne me surprend guère. Elle est le fruit d'un profond attachement de la communauté universitaire aux valeurs qui sont au fondement de l'Europe : le partage de la connaissance, la liberté académique, l'échange permanent pour contribuer à construire une société démocratique, basée sur le progrès et sur la science.

Frédérique Vidal

Les universités européennes auront vocation à définir une stratégie commune et de long terme à l'horizon 2025 pour la formation, la recherche et l'innovation. Des structures dédiées de gouvernance conjointe, ainsi que des services, ressources et infrastructures partagées seront mis en place.

Nous pouvons être collectivement fiers de cette réussite, à l'heure où les nationalismes rongent les fondements de la démocratie partout dans le monde, tandis que la science est de plus en plus questionnée, y compris parmi les responsables politiques de grandes puissances mondiales.



Les universités européennes sont une réponse européenne face à cette menace. Elles portent un message d'espoir tout autant qu'un impératif d'exigence. Demain, nous formerons des étudiants européens, qui auront un diplôme européen, parleront plusieurs langues européennes. C'est par la connaissance et par la science que nous développerons ce sentiment d'appartenance, ce destin commun qu'incarne l'Union européenne.

> "Les universités européennes auront vocation à définir une stratégie commune et de long terme à l'horizon 2025 pour la formation, la recherche et l'innovation. Des structures dédiées de gouvernance conjointe, ainsi que des services, ressources et infrastructures partagées seront mis en place."

Les universités européennes viennent compléter les multiples initiatives bilatérales qui fonctionnent déjà à travers l'Europe. Je pense notamment à l'Université franco-allemande, qui fête cette année ses 20 ans. L'UFA accueille 6,400 étudiants répartis entre 194 établissements d'enseignement supérieur. C'est également un bon exemple de ce socle historique de l'Europe qu'est la connaissance, grâce à ses 180 cursus intégrés d'excellence, grâce à la centaine de manifestations scientifiques qu'elle organise chaque année pour ses doctorants, grâce à sa promotion du plurilinguisme, qui est la véritable langue de l'Europe.

A travers les Universités européennes comme grâce aux coopérations bilatérales, c'est cette Europe de liberté, de solutions, d'opportunités en laquelle les citoyens ont tant besoin de croire que nous œuvrons. Dans cette Europe qui tremble parfois sous la montée des populismes mais qui vibre aussi de tant de créativité, de tant d'envie d'innover et d'inventer un monde plus solidaire et plus respectueux de l'environnement, les défis ne manqueront pas dans les mois qui viennent. ■

Frédérique Vidal
Minister of Higher Education, Research and Innovation
The French Government
Tel: + 33 (0)1 42 75 80 00
www.gouvernement.fr/ministre/frederique-vidal
www.twitter.com/VidalFrederique

Computer science and mathematics: Equality in proof assistants based on type theory

Dr Nicolas Tabareau from IMT Atlantique Bretagne-Pays de la Loire, details equality in proof assistants based on type theory, which falls under the umbrella of computer science and mathematics

The Coq proof assistant is a formal proof management system developed by Inria since the early 1990s. It provides a formal language to write mathematical definitions, executable algorithms and theorems together with an environment for semi-interactive development of machine-checked proofs.

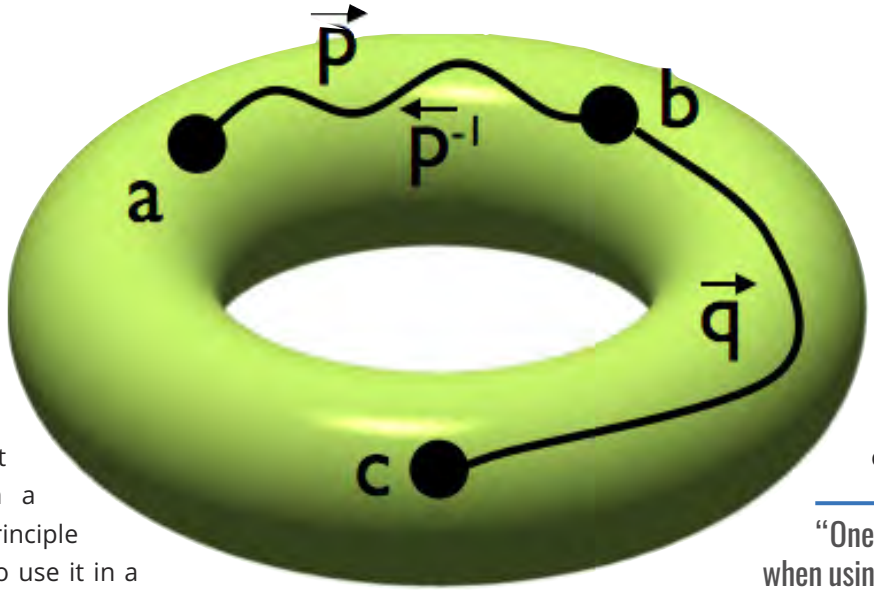
Every year, software bugs cost hundreds of millions of euros to companies and administrations, as assessed by Intel Pentium division bug or Ariane 5 first flight failure. Hence, software quality is a notion that becomes more and more prevalent, going beyond the usual scope of embedded systems. In particular, the development of tools to construct software that respect a given specification is a major challenge of current and future researches in computer science. Interactive theorem provers based on type theory, such as Coq, equipped with an extraction mechanism that produces a certified program from a proof, are currently gaining traction towards this direction. Indeed, they have shown their efficiency in proving the correctness of important pieces of software like the C compiler of the CompCert project. One major area of interest when using such theorem provers from a computer science perspective is the ability to extract the code that has been proven directly from the proof – being able to run it as any other pieces of code.

> "Every year, software bugs cost hundreds of millions of euros to companies and administrations, as assessed by Intel Pentium division bug or Ariane 5 first flight failure."

Unfortunately, the democratisation of such interactive theorem provers suffers from a major drawback, that is the mismatch between the conception of equality in mathematics and equality in type theory. Indeed, some basic principles that are used implicitly in mathematics – such as Church principle of proposition extensionality, which says that two formulas are equal when they are logically equivalent – are not derivable in (Martin-Löf) Type Theory. More problematically from a computer science point of view, the basic concept of two functions being equal when they are equal at every "point" of their domain is also not derivable and needs to be set as an axiom (see below).

Of course, those principles are consistent with Type Theory and adding them as axioms is safe. But any development using them in a definition will produce a piece of code that does not compute, being stuck at points where axioms have been used because axioms are computational black boxes. To understand this mismatch, we need to take a deeper look at the notion of equality in type theory. The only way to prove that two terms t and u are equal is by reflexivity, which means that the two terms must be convertible – in the sense that they have the same normal form. To some extent, this notion of equality is eminently syntactic. The reason why this notion of equality is used in type theory is that it comes with a nice elimination principle which allows substituting a term by an equal term anywhere in a type. This is Leibniz's principle of the indiscernibility of identicals. To the opposite, the notion of equality in mathematics is eminently semantics, with a definition that is relative to the type of terms being considered. This is why the functional extensionality principle is easy to set in this setting because the definition of equality is specialised accordingly

$$\texttt{Axiom}\ fun\_ext : \forall\ A\ B\ \{f\ g : A \to B\},\ (\forall\ x, f\ x = g\ x) \to f = g.$$



when it comes to function types. The problem with that point of view is that it does not come with a generic substitution principle and, thus, is difficult to use it in a programming language. This mismatch prevents proof developments from using more advanced semantical tools in their reasoning because of the explicit manipulation of mathematical equality together with axioms.

The birth of homotopy type theory

To correct the fundamental mismatch between equality in mathematics and type theory, Martin Hofmann and Thomas Streicher have introduced a new point of view on type theory, where types are not viewed as simple sets but as sets enriched with a homotopical structure. This way, each type comes with a specialised notion of equality and the homotopical structure describes how to substitute a term by another equivalent one in a type. Field medalist Vladimir Voevodsky recognised later that this simplicial interpretation of type theory satisfies a further crucial property, dubbed univalence, which had not previously been considered in type theory. The univalence principle coarsely says that two types (or structures) are equal if and only if they are equivalent (or isomorphic). The univalence principle subsumes the other missing principles of equality and is the key to equip type theory with a notion of equality that is compatible with traditional mathematical reasonings – it is at the heart of Homotopy Type Theory (HoTT).

The first outcomes of HoTT

This new point of view on type theory has now visible consequences in proof assistants such as Coq or Agda. For instance, to give a computational meaning to the univalence axiom, the cubical type theory has been developed by Thierry Coquand and his colleagues and implemented recently in Cubical Agda. In another line of work, a new universe sProp of definitionally proof irrelevant propositions has been implemented both in Coq and in Agda. The development of this notion of proof irrelevance – which guarantees that any two proofs of same proposition A are equal, no matter what they are – would not have been possible without the new insight provided by HoTT. Other outcomes of HoTT will likely be integrated into proof assistants during the coming years.

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> "One major area of interest when using such theorem provers from a computer science perspective is the ability to extract the code that has been proven directly from the proof – being able to run it as any other pieces of code."

Dr Nicolas Tabareau
IMT Atlantique Bretagne-Pays de la Loire
Tel: +33 251 85 82 37
nicolas.tabareau@inria.fr
coq.inria.fr

Boosting University research funding in the UK

Megan Warrender, Writer, examines the work of Chris Skidmore MP, Minister of State for Universities, Science, Research and Innovation, in particular, his endeavours to boost University research funding in the UK

Chris Skidmore MP is Minister of State for Universities, Science, Research and Innovation at the Department for Business, Energy & Industrial Strategy. He is currently the MP for Kingswood, South Gloucestershire and is the current Vice-Chairman of the Conservative party for policy in 2018.

He announced that University research was set to receive a major boost in funding. Research funding is set to receive £2.2 billion between 2019-2020, which is an increase of £91 million from 2018-2019. This is in the hope that more academic ideas and proposals can be translated to reality. This funding boost also includes an additional £45 million for quality-related (QR) research funding, which is a 2.3% increase from last year. This increase includes contributions to the National Productivity Investment Fund (NPIF) that supports universities to implement the government's Industrial Strategy.

This is a record high and Skidmore has commented, "I am delighted that for the first time since 2010, we have a significant uplift in QR funding for universities. One of my personal priorities has been to place universities at the heart of innovation for the future and I'm pleased to have worked to deliver on this."[1]

As well as this, Skidmore announced that postgraduate support for EU nationals has been extended another year. This is a guarantee for those starting postgraduate studies in the UK in 2020, and is yet another policy that shows Skidmore's ambitions in expanding research and development. He states: "Increased investment in research and development is a key ambition of the government which has committed to 2.4% GDP spent on R&D by 2027 – a vital part of our industrial strategy. The government has already committed to investing an additional £7 billion on R&D by 2021, the largest increase for 40 years."[2]

> "This new competition will not only help thousands of young people seize these opportunities but also become the next generation of digital entrepreneurs to stay at the global cutting edge of innovation – a key part of our modern Industrial Strategy."

Skidmore's reasoning to extending funding for international students is his belief in their contributions to UK universities and hopes that an extension of funding will be an incentive for them to come to the UK to conduct their studies. "International students make an important contribution to our world-leading universities. This is all about people – giving prospective students the reassurances they need to choose the UK for the next step in their academic career." This idea of continued collaboration between the UK and international students is part of Chris Skidmore's wider Industrial Strategy. One of the cornerstones of this strategy is that innovation, science and research know no borders.

As part of this strategy young entrepreneurs are being challenged to create apps and technologies that could help brighten the future. This is to be supported by £1 million of government investment specifically targeted at those between the ages of 11-16. This is set to be extracurricular and known as the Longitude Explorer Prize. It will be run by NESTA challenges who inspire innovators to solve some of the world's most pressing societal problems.

These apps or technologies are to be based around the 4 grand challenges: becoming greener; healthy ageing; cleaning up transport and the artificial intelligence (AI) and data revolution. These challenges are all identified in the modern industrial strategy laid out by Skidmore and the department of Universities, Science, Research and Innovation.

> "International students make an important contribution to our world-leading universities. This is all about people – giving prospective students the reassurances they need to choose the UK for the next step in their academic career."

As part of this scheme, students will also get the chance to work with industry mentors to help develop their products, giving them an exciting opportunity to create something with leading experts in the field. Elaborating further, Skidmore says, "this new competition will not only help thousands of young people seize these opportunities but also become the next generation of digital entrepreneurs to stay at the global cutting edge of innovation – a key part of our modern Industrial Strategy."[3] ■

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Physics: Nuclear Density Functional Theory for determining the properties of atomic nuclei

The Nuclear Theory Group at the University of York, United Kingdom, develops novel theoretical methods for a precise description of ground and exited nuclear states, more of which is explained here by Jacek Dobaczewski, Chair in Theoretical Nuclear Physics

How do we understand the origins of matter in the universe? This overarching scientific question passes through the analysis of properties of atomic nuclei, which since the late 1930s have been tirelessly studied in increasingly sophisticated experiments. The database of precisely measured masses, radii, electric and magnetic moments, excitation energies, transition rates, decay lifetimes and many other observables are now enormous. The overall understanding of this data, developed in parallel with the experiment, is good. However, is it good enough to declare victory? In fact, when it comes to details, systematics or extrapolations to uncharted territories, the precision of the quantitative description of nuclei is still far away from perfect. Nuclear theory still has plenty of challenging questions to answer. In particular, only now can we begin to build approaches that have controlled uncertainties and can be systematically improved.

Why is this so difficult?

The fundamental theory of atomic nuclei is the Quantum Chromodynamics (QCD), which says that nuclei are built of two quarks, up quark and down quark, which interact by exchanging gluons. The QCD equations of motion are deceivingly simple to write down and exceedingly difficult to solve. We witness fantastic progress in this direction, mostly owing to the development of advanced algorithms and the employment of the biggest available computers. However, the prospects of deriving properties of heavy nuclei from such a fundamental approach are still beyond the horizon. The reasons for this are twofold. First, the lower the energy the more difficult QCD equations become to solve. Second, at low energies, those that characterise atomic nuclei, quarks and gluons cluster into composite particles: protons and neutrons. Therefore, although fundamentally the atomic nuclei are built of quarks and gluons, at low energies they look like they were built of protons and neutrons.

Nuclear Density Functional Theory (NDFT)

The NDFT makes one further step; namely, it assumes that at energies where we do not clearly distinguish individual protons and neutrons, we can limit the theoretical description to using their densities only. This simplification allows us to describe all nuclei very efficiently. Indeed, in its simplest possible version, the NDFT operates with two densities, the proton density and neutron density, instead of hundreds of individual protons and neutrons. In practice, realistic implementations of NDFT must take into account several other densities, for instance, their derivatives up to a certain order. Moreover, for many observables, we still must recall that individual protons and neutrons are visible. However, altogether we have at our disposal a consistent and manageable theory that properly describes complicated composite systems like atomic nuclei.

What do we really do?

Our long-term goal is to build novel sophisticated and precise NDFT that would be systematically improvable and would quantitatively describe low-energy nuclear properties with well-defined controlled uncertainties. To illustrate our present-day activity let me give you two specific examples. The first one pertains to applications of nuclear theory and to how it can contribute to societal and technological developments. It relates to the properties of one very peculiar isotope of thorium, ^{229}Th, which has the first excited state at an unusually low energy level of 8.24 eV [1]. This energy is so low that the state can be manipulated with ultraviolet light. Typically, nuclear excitation energies are thousand or million times larger, so the excitation of a nucleus by ultraviolet light can be compared to steering a jumbo jet with a hairdryer. Using

Nuclear Density Functional Theory for determining properties of atomic nuclei

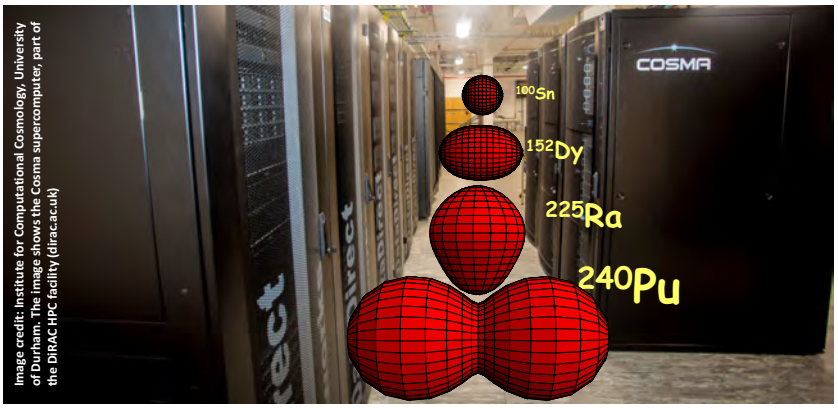
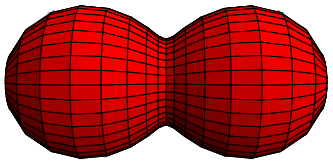
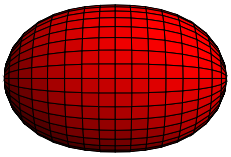


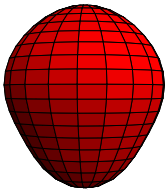
Image credit: Institute for Computational Cosmology, University of Durham. The image shows the Cosma supercomputer, part of the DIRAC HPC facility (dirac.ac.uk)



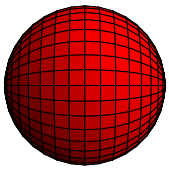
Shape of the fissioning nucleus ^{240}Pu on its path towards splitting into two identical fragments.



Shape of the superdeformed nucleus ^{152}Dy in its excited isomeric state.



Shape of the pear-shaped nucleus ^{225}Ra in its ground state.



Shape of the spherical doubly magic nucleus ^{100}Sn in its ground state.

^{229}Th, it may be possible to build a laser-induced nuclear clock of unprecedented precision, which can revolutionise applications like an ultra-precise Global Positioning System (GPS). The NDFT will never be precise enough to describe such low excitation energy; nevertheless, it is perfectly applicable to determining electromagnetic transition probabilities, which will be essential for future laser applications.

The second example is our study of ^{225}Ra [2]. This nucleus is the best candidate to measure hypothetical electric dipole moment (EDM) of the radium atom. Its unusual ground-state shape of a pear (see figure), favours detection of the parity-violating sector of strong interactions, which we were able to evaluate using our NEDF technology. If such non-zero EDM is ever measured, our calculations allows linking the experimental results to properties of parity-violating interactions and further, to a puzzling feature of our universe being built of the ordinary matter and not of the antimatter.

What does the future hold?

The nuclear physics studies that employ NDFT belong to the class of basic research that is curiosity-driven. It is the curiosity of what is around the corner that makes us tick. The history of science teaches us that basic research always leads to technological advances and improvements in human life. We do not know which part of it will, but it will undoubtedly. Teaching and training through basic research is the best way to form the minds of young people who then can do amazing things. The NEDF studies of atomic nuclei are an active area of basic research, giving us a possibility of extrapolating nuclear properties from stable to exotic systems and from terrestrial to stellar environments.

Finally, doing the NEDF research through one's entire life is absolute bliss and fun.

Chair in Theoretical Nuclear Physics at the University of York, Professor Jacek Dobaczewski.

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UNIVERSITY of York

Jacek Dobaczewski
Chair in Theoretical Nuclear Physics
University of York
Tel: +44 (0)1904 322 449
jacek.dobaczewski@york.ac.uk
https://www.york.ac.uk/physics/people/dobaczewski/
www.twitter.com/jacekdob512

Building a stronger European Research Area

Maud Evrard, Head of Policy Affairs at Science Europe, shares her views here on building a stronger European Research Area. We find out that performing excellent, ground-breaking research in Europe in this vein, is a priority

The Lisbon Treaty describes the European Research Area (ERA) as a unified research area that is open to the world and based on the Internal Market. The ERA enables free circulation of researchers, scientific knowledge and technology. It also enhances the competitiveness of Europe and allows for the development of solutions to the global challenges that face us. Despite a common view of the goal and benefits of the ERA, the question of how to implement it has unfortunately been the subject of a longstanding debate.

To bring together several of the key stakeholders in developing the ERA, Science Europe organises an annual High-Level Workshop on the topic. Currently in its 11th year, this event offers a much-needed platform for science policy debates between decision-makers from Science Europe Member Organisations, national ministries for research and innovation and the European Commission. Science Europe sees this kind of engagement with key partners as one of its direct contributions to the strengthening of the ERA. However, wider commitment and engagement is needed to collectively build the ERA.

> "To help build a stronger and more effective ERA and shape the future of research, Science Europe advocates a better integration of the scientific community in policymaking."

For future success, Science Europe calls for the uncompromising promotion of scientific excellence at the highest level and the development of the scientific capacity in all regions of the ERA. Both requirements should be pursued in a complementary approach and not be artificially combined. They are the cornerstone

for Europe's leading role in global research and development and for a coherent and inclusive Europe.

Furthermore, research collaboration has often been seen as a powerful tool to promote European values around the world. Today, in some parts of Europe, one of these values and a key component of the ERA – academic freedom – is no longer self-evident. This has grave consequences for scholars, science and society. A well-functioning ERA must recognise the fundamental importance of academic freedom and institutional autonomy and it must strive to guarantee these to all scholars in the ERA and beyond.

"To bring together several of the key stakeholders in developing the ERA, Science Europe organises an annual High-Level Workshop on the topic. Currently in its 11th year, this event offers a much-needed platform for science policy debates between decision-makers from Science Europe Member Organisations, national ministries for research and innovation and the European Commission."

Another challenge for the ERA, as also identified by the European Parliament, is the absence of clear, shared definitions regarding its very concept and related ones in the Framework Programmes for Research and Innovation, such as impact. Science Europe advocates using the value of research as a central concept to the ERA. Wider than impact, it recognises the intrinsic value of scientific research and its capacity to generate new knowledge. The value of research can take many forms and can be found everywhere: from technological breakthroughs and practical applications to intangible cultural value and education; from political, social, economic and environmental changes to intrinsic value that society attributes to knowledge itself.

To help build a stronger and more effective ERA and shape the future of research, Science Europe advocates a better integration of the scientific community in policymaking. Whether this involves promoting full and immediate access to research results, reviewing research assessment practices and their implications on researchers' careers, securing adequate structures to support high-risk research, or ensuring the adoption of research-friendly legislation at the European Union level, Science Europe recognises that science policy developments can only yield tangible results when informed by consolidated advice from scientists. Science Europe, therefore, calls for their voice to be taken into account. ■

Science Europe is the association representing major public organisations that fund or perform excellent, ground-breaking research in Europe.

Maud Evrard
Head of Policy Affairs
Science Europe
Tel: +32 (0)2 226 0300
office@scienceeurope.org
www.scienceeurope.org
www.twitter.com/scienceeurope

Challenges in training in modern optical technology

Toralf Scharf, Senior Scientist/Faculty Member at École polytechnique fédérale de Lausanne, charts today's challenges in training in modern optical technology

Today, all optical designs are often perceived following different approaches, namely geometrical optics, physical optics and nano-photonics. Traditionally these approaches are linked to the different lengths-scale that are important to the system. Starting from the entire system that is macroscopic and uses geometrical optics, over the miniaturised unit that is based on micro-optics and needs physical optics design, down to the active nano-photonics entity that allows steering light truly at the nano-scale but which requires to be designed with rigorous methods that provide full-wave solutions to the governing Maxwell's equations. A design for the manufacture of next generation optical applications necessarily requires bridging the gap between the different length scales and to consider the design at a holistic level.

Our project "Noloss: Lossless photon management – Optical design for manufacture at different length scales" is tailored to educate the future generation of optical engineers to successfully cope with this challenge. So how do we prepare and train future engineers for the design challenges and opportunities provided by modern optics technology? In a situation where university research is often decoupled from high technology fabrication, this becomes a challenging task. The necessary education can only be based on real- world scenarios together with industry and a multitude of projects running in parallel to achieve a "critical mass" of scientific subjects and allow cross-disciplinary exchange.

In our work, supported by the European Union's (EU's) Horizon 2020 initiative we, therefore, brought together key players of optical technology in Europe and proposed a training programme where themes and problems are provided by industry. The research-oriented partners from academy add necessary scientific visions on different subjects, such as small-scale optical systems, nano-photonics and micro-optics. Usually, university training happens in single institutions, which is very limiting when it comes to gathering experience about applications. In our case, the future PhDs are working more than half of their time in industry and learn research and technology transfer on the job.

In terms of our approach, we defined these three objectives that focused on training:

- Provide an integral educational platform for optical specialists that allow the education of engineers in an interdisciplinary environment and to operate outside their field of specialisation.
- Provide access to a doctoral (PhD) education programme that is based on state-of-the-art product development techniques and leading technology platforms available in Europe.
- Unite the education in different optical disciplines from nano-photonics and micro-optics to optical systems providing interdisciplinary product development based on optical technologies.

The research objectives are based on high-level research activities in the industry and focus on the problems that are identified as the main gaps and bottlenecks for optical system developments and commercialisation when miniaturisation is considered. We identified as the main research goal of our proposal:

- Apply innovative micro- and nano-optics technology to important real-world industrial applications, such as energy conversion (solar cells), imaging, sensing, or lighting.

But what is different in our research work compared to purely academic research? In our case of research work, ample attention is given to important practical aspects that are normally left out of consideration, such as the one very important aspect: the limitations set by manufacturability.

In more detail, three research objectives are considered for each of the activities:

- Help industry to solve the most eminent design problems related to nano-micro-optical systems, such as optical multi-scale simulation.

- Develop optical system design strategies for the future of the optical industry that are close to manufacturing processes and assure compatibility of integration into macroscopic systems.

- Develop and transfer the latest optical design techniques out of the laboratory to be used by industry.

Such challenges include lossless photon management, modelling at the system, components and feature level and the link between design and technology. All this need to consider manufacturability of the invented structures and concepts.

Lossless photon management is the key in optical system design and applications today. It basically suggests that all photons are steered in a way that they fully contribute to the functioning of the system. All losses that are created by either absorption of light or scattering into undesired channels should be avoided. Two main impact areas of lossless photon management can be identified that are of major concern to our future society: energy saving and enabling functionality.

Energy saving is introduced on different levels for optical technologies and applications. It is not only important to fabricate highly efficient elements, but one needs to consider the fabrication process of the elements and systems itself. An effective starting point is the use of state-of-the-art technologies but to fully explore its potential one has to optimise the design for the manufacture. Such a strategy was successfully applied in the semiconductor industry and will be the key to success for future optical technologies. This requires linking in a highly integrated manner the design of individual optical components and entire optical systems with the manufacturing processes required.

Enabling functionality is a second important field for optical systems that can be reduced to a single characteristic: contrast. An optical system will always be judged by its ability to measure signals against a background. If all photons contribute to the signal, the background can be neglected and no photon is lost. Consequently, the signal-to-noise ratio becomes maximum. In miniaturised systems, such argumentation is particularly important, because miniaturisation is often used as a synonym for nomadic and battery-powered devices. Efficiency and lossless photon management translate then directly into new applications, better performance and longer lifetime. To enable optical functionality with maximum efficiency, an integral design approach is needed that allows establishing photon budgets from the source (including energy conversions effects) to the detector. Again, the aspect of fabrication limitations within the design is the most important factor for success.

At the core, are optical simulation models developed and used in the academic research and the one used for optical designs in industry. Up to now, only the academic partners apply an integrated approach to include micro- and nano-photonics in their simulations. Together with the industrial partners, small-scale research projects are launched to promote the academic developments in optical design and simulation over different length scales. The industry will use the know-how to consolidate their expertise, expand their businesses and occupy new fields of activities. For each research subject, may it be nano-photonics, micro-optics or system engineering, a communication channel can be provided to access particular knowledge and/or stimulate collaborations.

As an outcome, highly trained optical engineers will be able to operate in different worlds after completing their PhD because they will have experience in both academia and industry. They can easily integrate into different environments, which is the key to today's dynamic workplaces. Packed with this rich experience, students have a much better starting condition to pursue their career path as future leaders in the optical industry.

Toralf Scharf focuses his research activities at the École polytechnique fédérale de Lausanne on interdisciplinary subjects, bringing micro-system, material technology and optics together. With a background in surface physics (MSc), physical chemistry (PhD) and a profound experience in optics, he is familiar with all necessary aspects of technology development and application and can communicate with different scientific communities. In over 20 years of project execution with industry and governmental organisations, he has accumulated the right experience to lead and execute the project at different levels.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Sklodowska-Curie grant agreement No 675745.

NOLOSS
Lossless photon management
Optical design for manufacture at different length scales

EPFL

Toralf Scharf
Senior Scientist/Faculty Member
École polytechnique fédérale de Lausanne (EPFL)
Tel: +41 21 695 4286
Toralf.Scharf@epfl.ch
www.nolossproject.eu
www.twitter.com/NolossP

The need for more balanced internationalisation in higher education

Ingrid van Engelshoven, Minister of Education, Culture and Science, recently shared her thoughts on the need for more balanced internationalisation in higher education, more of which we learn about here, as well as the wider work of the Ministry she is a part of

In the Netherlands, the Ministry of Education, Culture and Science aims to create "a smart, skilled and creative environment." For the Ministry, it is key that everybody can enjoy a good education and is, therefore, ready for independence and responsibility in the future. Ensuring that scientists, teachers, artists can undertake their work is another one of the Ministry's important objectives.

Minister of Education, Culture and Science

This article will focus on the work of Ingrid van Engelshoven, current Minister of Education, Culture and Science in the Netherlands. She recently commented on the need for more balanced internationalisation in higher education. The Ministry of Education, Culture and Science believe that students from other countries enhance Dutch research, the job market and the economy. Certainly, internationalisation in higher education is of tremendous value to Dutch society but the growing numbers of international students must not reach extremes, according to the Ministry.

Internationalisation in higher education

A recent Interministerial Policy Review (IBO) underlines that internationalisation might threaten the funding, accessibility and quality of education. In response to this, the Government of the Netherlands aims to bring in stricter rules on the language of instruction, restrict the intake on courses taught in a language other than Dutch, and increase fees for students from outside the European Economic Area (EEA).

Looking at the broader landscape, the aforementioned measures are part of the Language and Accessibility Bill, which builds on the IBO recommendations on internationalisation in higher education. In recent news, we learn that the cabinet has approved Ingrid van Engelshoven's proposal to put forward the bill to the House of Representatives. On this matter, the Minister explains more in her own words.

"Internationalisation in higher education is a boon for our knowledge economy, the private sector and the job market. Long may this continue! However, research shows that the proliferation of foreign students and courses taught in English is putting too much pressure on higher education here. There's a real risk that the system will soon be unable to cope with the numbers of new students. It will squeeze funding for higher education and also crowd out Dutch students. So I'm introducing these measures to safeguard the quality and accessibility of higher education, and ensure that the international dimension is more in harmony with other aspects of Dutch higher education."

A greater focus on proficiency in Dutch

The minister wants to avert the trend concerning the growth in the number of international students and English-taught courses that could undermine the proficiency of Dutch students'. "As the Minister of Culture, I also have a strong vested interest in the Dutch language," Ms van Engelshoven underlined. Currently, the law expects higher education institutions to promote Dutch-language proficiency among students in the country. We read more details on the website of the Ministry concerning this important policy development.

"The proposed amendment will extend this requirement and make institutions responsible for facilitating foreign students' acquisition of Dutch, too. This will enhance the students' links with their host community

Ingrid van Engelshoven, Minister of Education, Culture and Science

and the regional job market, increase their employability and strengthen the position of Dutch as a language of scientific research. It will also raise the chance that international students stay on in the Netherlands, which is good for the job market."

Tuition fees: Stricter regulation

Finally, one other aspect of this development concerns the stricter regulation of tuition fees for non-EEA students. Minister van Engelshoven wants to introduce a higher minimum rate for tuition fees payable by non-EEA students. The idea behind this thinking is that student flows from outside the EEA do not have negative financial effects on the institutions concerned. (1)

Concluding thoughts

This recent development in policy is an excellent example of the wider work of the Ministry of Education, Culture and Science to, "create a smart, skilled and creative environment in the Netherlands" and we wish them well for the future as they continue, "to ensure that everyone gets a good education and is prepared for responsibility and independence." (2) ■

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editorial@openaccessgovernment.org
www.openaccessgovernment.org
www.twitter.com/OpenAccessGov

Health and human welfare in the 20th century: Escaping early death, poverty and poor health

Herman de Jong from the University of Groningen, explores health and human welfare in the 20th century, with a focus on escaping early death, poverty and poor health

Over the centuries, human societies have gone through countless transformations affecting the wellbeing, health and quality of life of people around the world. In many parts of the world, the advent of the 20th century resulted in a clear break from the challenging past marked by widespread poverty and illness. Nobel laureate Professor Angus Deaton described it as a 'Great Escape' from the previous reality marked by early death, poverty and poor health. Despite the devastating world wars and economic struggles that marked the first half of the 20th century, this historical period brought exceptional advances in health and human welfare of a large number of countries.

Traditional indicators of human living standards, like Gross Domestic Product (GDP) per capita, do not capture adequately these improvements in welfare trends. [1] Nowadays, in addition to GDP, economists consider other important factors affecting living standards within nations, including working wages, consumption, mortality rates, life expectancy, inequality, schooling and leisure time. Using a multi-dimensional framework of human development, we can take a new and closer look at changes in human living standards and health during the 20th century.

A better understanding of the changes brought by the 20th century could have far-reaching implications for the present day. This includes informing how we should best measure the welfare of nations and encouraging the use of more comprehensive approaches that consider a range of different dimensions of the economy and citizens' health.

Human welfare in the early 20th century

Applying this broader welfare approach, Daniel Gallardo Albarrán reported in a recent paper that income growth significantly underestimated welfare growth in Western Europe between 1913 and 1950. [2] Taking Britain as an example, in 1950, British citizens were at far lower risk of infectious diseases, had an increased life expectancy of 16 years, lived in a more equal society and spent almost 500 hours less per year at work compared to 1900. For Europe as a whole, GDP per capita showed an improvement of less than 30% between 1913 and 1950, the composite indicator of welfare suggests that the wellbeing of citizens approximately doubled.

Between 1900 and 1950, death rates declined substantially. By the late 1940s, many European countries had a rate of 9-14 deaths per 1,000 of population, coming down from 16-27 in 1900. Infant mortality decreased from 90 per 1,000 births to 25. Many of these impressive results were the fruit of 19th century improvements in health, which were driven by the germ theory and by investments in public health, such as the cleaning of water supply, sewage facilities, the setting of housing standards and the clearing of slums. These results persisted, primarily due to further low-cost improvements in sanitation and medical knowledge (new vaccines, antibiotics), which allowed major infectious diseases to be treated.

The global picture of health and human welfare

How do these early 20th century improvements compare with other regions in the world and with the post-WWII period? In a recent study, Leandro Prados de la Escosura has presented a so-called adjusted Historical Index of Human Development. [3] Around 2007 human development levels in Central and Eastern Europe and Latin America matched those of the OECD countries in the late 1960s; in 2007 China and India had achieved levels of OECD in respectively 1960 and 1929. This is mainly an effect of much higher levels of post-WWII life expectancy of developing countries compared with the rich countries in the early 20th century. However, this

index also reveals that the gap between OECD countries and the rest has widened again in absolute terms. Although there was educational expansion and recovery of income growth at the end of the 20th century in many areas in the world, the non-OECD areas failed to catch up with the longer life expectancies in the Western world. Within the OECD area, there has been a renewed contribution of life expectancy to human development since 1990, in the present case not from saving the lives of children (which was the first or epidemiological health transition), but from saving the lives of middle-aged and elderly in rich countries. This so-called second health transition has resulted in a falling rate of mortality among the elderly through better treatment and better general health and nutrition circumstances. In its turn it was a result of increasing demand for more healthcare to make our longer life more bearable ('healthy ageing'), reflecting higher real incomes.

Improved health of the elderly in society is an income-elastic good. If healthcare is becoming more dependent on income growth and less on public policies, like it was in the early 20th century, this may lead to even higher inequality of welfare levels across nations in the future. But we need to put this in the right perspective. Healthcare per capita spending in the U.S. is close to 10,000 dollars per year and is more than two times higher than in the U.K. But this difference is not reflected in differences in life expectancy. Probably, the saving of lives is still mainly an effect of (past) public health measures, better nutrition, access to education and less the result of clinical medicine and interventions.

Health transitions take time

Indeed, annual per capita expenditures on health vary enormously across countries. In most Sub-Saharan African countries, health expenditures fluctuate below or around 200 dollars per person per year. In Bangladesh, Pakistan and India these levels are 88, 134 and 238 dollars respectively. Minimising the exposure to environmental insults during infancy will increase longevity. The distribution of drugs and vaccines in the developing world and impoverished nations to combat tuberculosis, malaria, measles and all kinds of infections will have positive effects on life expectancy at modest costs. History has shown that this is a long process, but it will finally show up in the health statistics.

These research results present a valuable opportunity for both methodological and policy-related developments. From a research perspective, it could lead to the implementation of more comprehensive but realistic measures of welfare that consider a broader range of factors affecting citizens' wellbeing, including health and health services. Future research may also pay greater attention to trade-offs associated with income and income inequality and could benefit governments and policy-makers by helping them identify critical areas of welfare to prioritise in their interventions. It could also help to shift the primary focus of governments from increasing GDP to developing policies that address a broader range of economic and health-related issues. The 20th century shows that we do not always need economic growth to produce higher levels of wellbeing.

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university of groningen

Herman de Jong
Professor
Faculty of Economics and Business
University of Groningen
Tel: +31 50 363 3737
h.j.de.jong@rug.nl
https://www.rug.nl/staff/h.j.de.jong/

The importance of funding Dutch science

Now is a challenging time for science. Here, we learn about the importance of funding Dutch science and research to help tackle complex societal issues

Today is a challenging time for science. It is increasingly being called upon to help tackle complex societal issues, and is reaching more aspects of everyday society more than ever. The Dutch Research Council (NWO) places the utmost importance on funding top researchers, steering the course of Dutch science by research programmes and also managing the national knowledge infrastructure. NWO's core task is to fund talented scientists and research facilities. The selection process of research proposals is through a peer-reviewing process, based on the advice of specialist scientists and relevant experts in the Netherlands and abroad.

> "Striving for a diverse organisation with an inclusive culture where everybody is needed, irrespective of cultural, ethnic or religious background, gender, sexual orientation, health, and age is something that NWO prioritise."

NWO successfully manages this competitive research funding and ensures that the money reaches the best scientific talent and the best research proposals. NWO funds specific scientific research that contributes towards solving societal challenges, showing its belief that this funded research is beneficial to all corners of society. Today, it funds more than 5,800 research projects at universities and knowledge institutions every year, focusing on all scientific disciplines and fields of research attempting to leave no stone unturned.

NWO operates within the following core values that are vital for successfully realising its ambitions and accomplishing its goals:

- **Ground-breaking**
  Both pioneering and exploring the boundaries of existing knowledge.

- **Committed**
  Always anticipating developments in science and society.

- **Reliable**
  NWO states that it keeps its promises, is honest, transparent and meticulous.

- **Connecting**
  Maintaining an open attitude, connecting expertise and agendas.

This final core value – 'connecting' in modern society is, in fact, the main aspect of the NWO's strategic plan from 2019 – 2022 'Connecting Science and Society'. NWO emphasises its vision as a connecting role by making connections within science and between science and society together with its knowledge partners. Forward-thinking developments require more collaboration in the science system and more dialogue between science and society. Besides a strong disciplinary basis, facilitating collaboration between disciplines, across sectors and throughout the knowledge chain and with societal partners is undoubtedly more necessary than ever before. NWO facilitates excellent, curiosity-driven disciplinary, interdisciplinary and multidisciplinary research, connecting researchers from various disciplines and across the entire knowledge chain and thus bringing researchers and societal partners together. Furthermore, NWO invites partners from industry, the government and societal organisations to contribute with their own knowledge agendas and questions to the programming, realisation, and co-funding of research.

Here we can see active examples of how NWO will continue to place considerable emphasis on collaboration in light of developments in science and society today. Harmonising the current funding instruments to

facilitate collaboration which, as a result, researchers, irrespective of the research domain, will be subject to the same conditions, is, in fact, an extremely effective way of ensuring accessibility to all, and also contributes to NWO's focus on inclusivity within research. NWO states that it wants to be an organisation where everyone feels welcome and can bring out the best in themselves and teams. Striving for a diverse organisation with an inclusive culture where everybody is needed, irrespective of cultural, ethnic or religious background, gender, sexual orientation, health, and age is something that NWO prioritise. "We can only achieve that if we shift the goalposts and change patterns, structures and processes. We will do this by focusing our attention on our granting policy and employer's policy." [1] This will strengthen research in the Netherlands, breaking down the barriers that still prevail today in science.

Here NWO emphasises its connecting role, and does this yet again through the importance it places on open science. An important part of the budget is spent on open research and talent programmes. NWO believes that research results paid for by public funds should be freely accessible worldwide, (including both scientific publications and other forms of scientific output.) In principle, it must be possible to share research data with others as well. This allows valuable knowledge to be used by researchers, companies and public organisations throughout the Netherlands and other parts of the world.

It is true that the Internet has radically changed the possibility to disseminate scientific knowledge. Therefore NWO's open access aims to make the outcomes of scientific research freely accessible worldwide for everybody. It is beneficial because open access increases the impact of research results, open access publications are easier to find and are more likely to be cited, and it also ensures that public organisations and companies have access to the most recent and up to date scientific insights. Emphasis on these areas can only have positive results on Dutch research. Cooperation is key.

It is clear to see that as well as funding, NWO influences, supports and connects. As its mission is to advance world-class scientific research that has scientific and societal impact, ensuring not just quantity, but high-quality research, this causes us to question, why is fundamental research the basis of excellence and innovation? This research allows for opportunities to innovate the world as we know it, from anything as vast as "purifying wastewater under extreme conditions" [2] to a cafe that is "challenging masculinity to stop violence against women in Bangladesh." [3] Thousands of scientists can conduct their research thanks to financial support from NWO. There are without a doubt numerous benefits of research, and research leads to results. Dutch research is highly regarded and is effective thanks to a smart combination of collaboration, competition, quality assurance, and a good infrastructure. The Netherlands wishes to maintain and strengthen this leading position. Promoting research is vital to ground-breaking innovation in the Netherlands. ■

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The Moonshot Research and Development Program: Challenging research and development towards the future

Hirai Takuya, Member of the House of Representatives and former Minister of State for Science and Technology Policy in Japan, shares his thoughts on The Moonshot Research and Development Program, that challenges research and development towards the future

Our society faces various challenges that must be addressed, such as an ageing population and the declining birthrate in developed countries, large-scale natural disasters and global warming. Japan has been promoting "Society 5.0," a notion of a human-centred and inclusive future society that realises both economic growth and the resolution of societal challenges by a sophisticated integration of cyberspace and physical space.

With the aim to develop radical solutions for difficult societal challenges, the Government of Japan announced the establishment of **the Moonshot Research and Development (R&D) Program** in 2018. It is an endeavour to accelerate disruptive innovations by promoting challenging R&D to achieve ambitious goals or the Moonshot Goals which inspire people in the world. The Government of Japan has allocated a budget of more than 100 billion Japanese yen (about $1 billion) for five years as seed money.

At the end of July this year, the Visionary Council of the Moonshot R&D Program recommended three areas and 13 visions to identify the Moonshot Goals for the program. The council also indicated 25 candidates for the Moonshot Goals. The Government of Japan plans to invite distinguished scientists, engineers and innovators from around the world to provide advice setting out the Moonshot Goals.

To this end, the Government of Japan is organising **the Moonshot International Symposium** in Tokyo from December 17th to 18th, 2019 in order to discuss the Moonshot Goals and innovative ways of conducting Moonshot research.

Fully taking into account the outcome of the symposium, the Council for Science, Technology and Innovation (CSTI) chaired by the Prime Minister will set out the Moonshot Goals for the program.

Areas and visions for the Moonshot Goals

The Areas for the Moonshot Goals, recommended by the Visionary Council are:

1. Tackling declining-birthrate and an ageing society with radical innovation.

2. Recovering our civilisation and healthy global environment.

3. Pioneering new frontiers with science and technology.

The Visionary Council also recommended 13 Visions for the three areas above as follows:

Area 1:

- Inclusive society: anyone can pursue their dreams (inclusion and innovation).
- A society without health anxiety: everyone can enjoy life until 100 years old (achievement of well-ageing).
- Industrial innovations by complete automation.

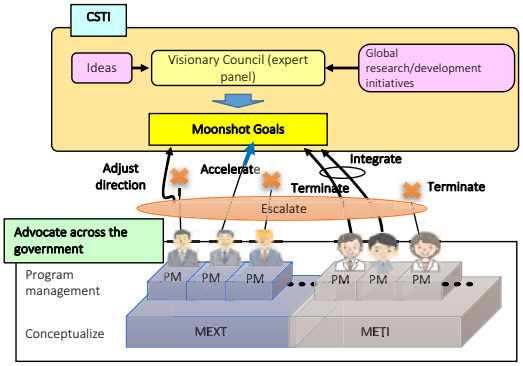
Area 2:

- Significant reduction of resources requirements.
- Full recycling of resources.

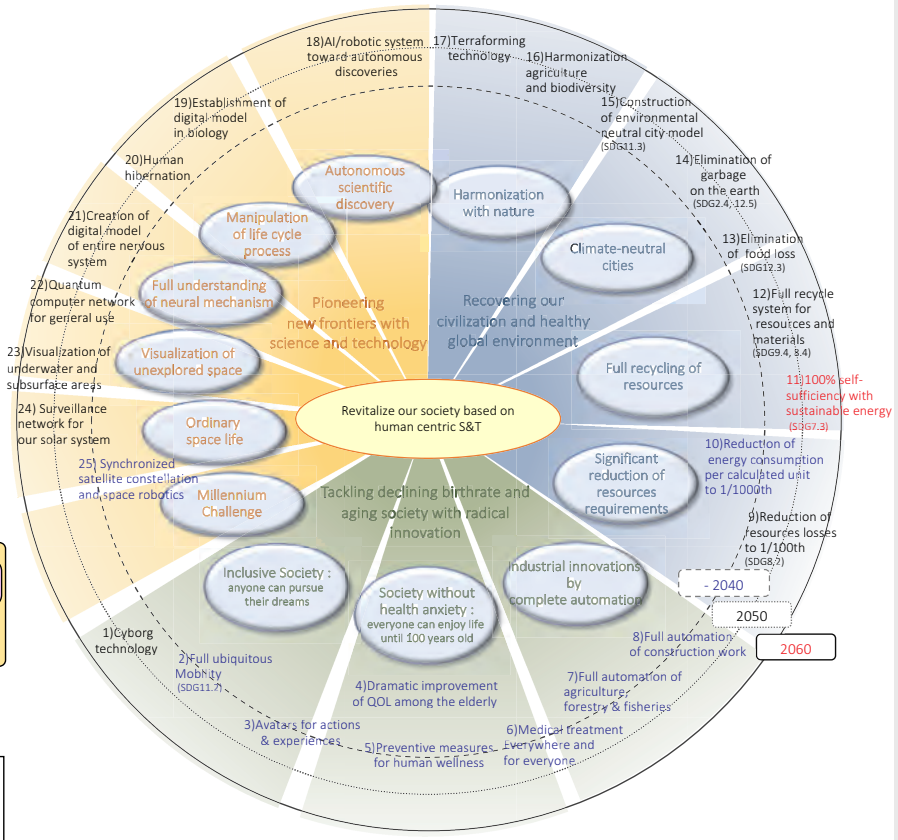
The Moonshot Research and Development Program (overview)

【Key points】

- ✓ The government sets ambitious targets and concepts for a social agenda that are difficult to tackle but will have profound impact once resolved.
- ✓ Top-class researchers at the helm of cutting-edge research will lead teams of international researchers.
- ✓ Advocate challenging research and development initiatives that will maximize Japan's basic research capabilities by identifying and developing innovative research and development activities without being afraid of making mistakes.
- ✓ Develop the most advanced system to support cutting-edge research with a flexible structure for adjusting its organization and activities, encompassing the entire range of related research and development initiatives in line with the development and evolution of global researches and developments.



【Areas, Visions and examples of Moonshot Goals】



- Climate-neutral cities.
- Harmonisation with nature.

Area 3:

- Autonomous scientific discovery (AI).
- Manipulation of the life cycle process (biotech).
- Full understanding of the neural mechanism (brain/nerve system).
- Visualisation of unexplored space (from quantum to the Earth.)
- Ordinary space life (space).
- Millennium Challenge (public call for Vision and Goals).

International participation in the Moonshot R&D Program

The Government of Japan welcomes international participation in the Moonshot International Symposium in December.

In addition, the Government of Japan would like to invite distinguished scientists and engineers and young talent from around the world to the Moonshot R&D Program to co-work for the future of our societies. ■

For more information on Science, Technology and Innovation, please visit: https://www8.cao.go.jp/cstp/english/index.html

For further details of the Visionary Council on the Moonshot Research and Development Program (Fourth Meeting), please visit: https://www8.cao.go.jp/cstp/english/moonshot/4th/index.html

Hirai Takuya
Member of the House of Representatives, Former Minister of State for Science and Technology Policy, Japan
Cabinet Office, Government of Japan
Tel: +81 3 6257 1328
moonshot-symposium@cao.go.jp
www8.cao.go.jp/cstp/english/
www.twitter.com/hiratakuchan
www.facebook.com/hiratakuchan

User-Centric Platform PRINTEPS for Unified AI Robot Applications

Takahira Yamagichi of Keio University dives into the PRINTEPS platform, explaining how it helps AI Robot Applications to be more easily to develop

Whilst AI Robot applications are becoming popular in many domains, they should work with users and the users should be able to work the development process with ease. Thus, AI Robot development tools should integrate different types of intelligent software modules. They should also give the users development processes that work well with them.

1. What type of AI Robot Development Tool is necessary for Users?

Thus we aim to develop PRINTEPS (PRactical INTEligent aPplicationS), which is a user-centric platform to develop unified AI robot applications by integrating five types of software modules. PRINTEPS also supports users to care about AI application design and to develop and revise it easily. PRINTEPS project has been funded by the CREST initiative launched by the Japan Science and Technology Agency, which promotes intelligent information processing systems aimed at harmonious collaboration between humans and machines.

2.PRINTEPS Architecture

PRINTEPS works for users to develop unified AI Robot applications by integrating five types of software modules: knowledge-based reasoning, speech dialog, image sensing, motion & manipulation planning and machine learning with deep learning. The knowledge-based reasoning module includes workflows, business rules, and ontologies. The spoken dialogue module refers to response generation rules, dialogue processing rules, and language understanding rules. The image sensing module has object and human behaviour recognition. The motion and manipulation planning module also include obstacle recognition and dynamic/intelligent route planning. Machine leaning consists of conventional machine learning such as decision tree learning, Bayesian networks, Random Forest and deep learning such as convolutional neural networks and LSTM and so on.

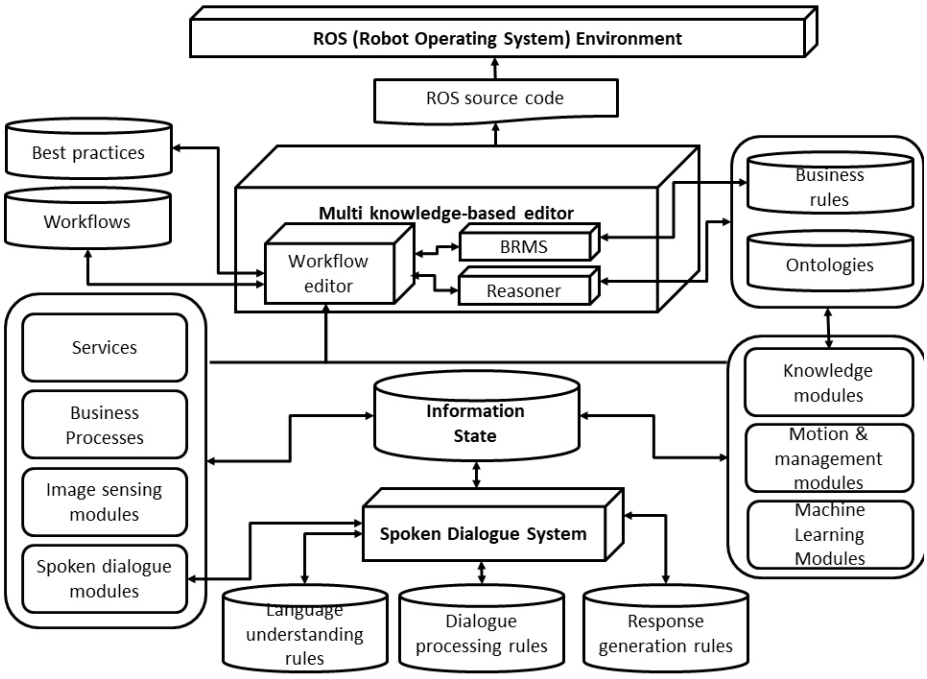


Figure 1. PRINTEPS Architecture **(Click to enlarge)**

Figure 1 shows the architecture of PRINTEPS. PRINTEPS is based on Robot Operating System (ROS), which is a robot middleware and offers communication libraries and various tools. In ROS, a user can employ services, which have a synchronous communication mechanism, and topics, which offers a mechanism for asynchronous communications. Because ROS is implemented as a distributed system, ROS facilitates how to handle multiple robots or sensors, and the use of topics enables various other processing operations, including the real time acquisition of sensor values.

Information State (IS) in PRINTEPS is a database for sharing data among intelligent software modules. PRINTEPS takes MongoDB store, which is a MongoDB-based storage and analysis for data from a ROS system, as IS. In

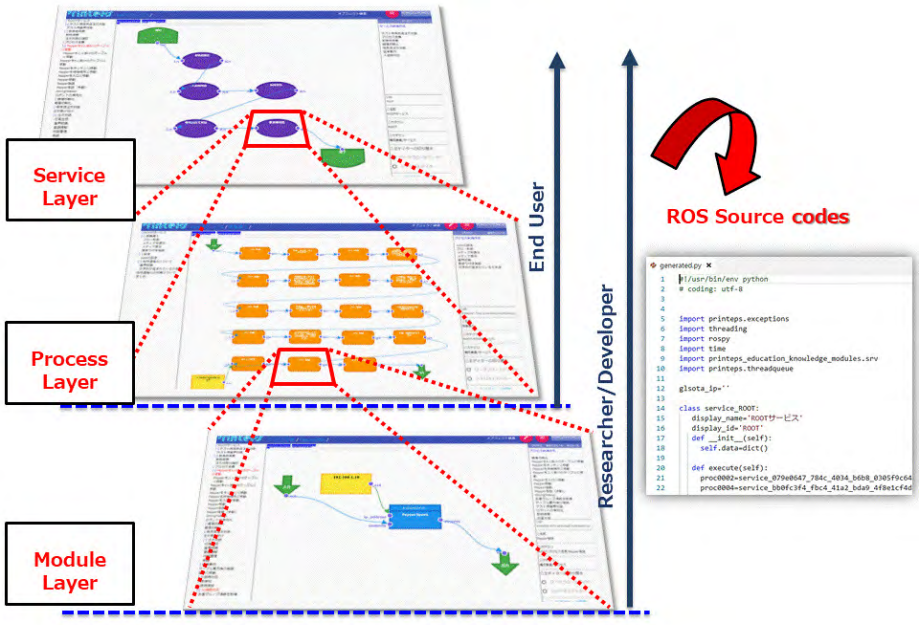


Figure 2. Three layers with PRINTEPS **(Click to enlarge)**

PRINTEPS, each software module stores data to IS and refers data from IS. The data format in PRINTEPS is the format of messages in ROS.

PRINTEPS also provides a multi knowledge-based editor for users to develop integrated intelligent applications easily by combining software modules from PRINTEPS. The details of the editor are described in the next section.

3. Multi Knowledge-based Editor

The multi knowledge-based editor consists of a workflow editor and a Business Rule Management System (BRMS).

3.1 Workflow Editor

Users can develop workflows using components based on SOA (Service Oriented Architecture) by the workflow editor. The main components in the workflow editor are services, processes and modules, as shown in Figure 2. The modules are primitive functions and they are fully compliant with ROS services, topics, and messages. The processes play a function-like role in which they deal with multiple modules. In process operation, the processes and modules can be defined in a mixed manner. The services are functions with the coarsest grain size and are composed only of processes defined as business processes. The first hierarchy (route service) of the workflow editor is composed of a route start, service list, and route end. The service list, when completed, will be shared among users as a case library (best practice). It will allow users to locate easily those services, processes, or modules used as best practice. The workflow editor automatically generates source codes in Python that can be executed in ROS.

3.2 Business Rule Management System

BRMS includes a Business Rules Engine (BRE), a web authoring and rule management application. PRINTEPS takes Drools as BRMS. Since BRMS has a function to define rules with domain specific language, users can then easily describe business rules with natural-language like form.

In PRINTEPS, "fire business rules" module in the workflow editor can execute business rules in BRMS and BRMS can execute modules in the "then-part" of business rules. The big difference between a traditional knowledge-based system and an integrated intelligent application is that sensing results such as person attributes from an image can be described in the "when-part" of business rules and robots action such as speaking and moving to a certain place can be described in the "then-part" of the business rules.

4. Conclusion

We apply PRINTEPS to two real cases: Robot Café/Restaurant and TA Robots in primary schools. The results will be described in future issues.

Human-Machine Harmonious Collaboration

Printeps

JST Japan Science and Technology Agency

Keio University 1858 CALAMVS GLADIO FORTIOR

Takahira Yamaguchi
Professor
Keio University
Tel: 81 45 566 1614
yamaguti@ae.keio.ac.jp
www.yamaguti.comp.ae.keio.ac.jp/en/yamaguti/index.en.html

Meeting the real-life enterprise taking humans to the final frontier

Dr Lena De Winne, Head of Information and Communications at Asgardia, speaks of how the endeavours of the billionaire class could soon become a reality for a mass audience

Throughout the decades, the gallivanting escapades of the Starship Enterprise – traversing the depths of where no-one has gone before – has enthralled and inspired generations. What seemed like a distant dream for those wishing to cruise the final frontier, could soon become a reality. With the enterprising spirit of some of the world's leading business moguls striving for the expansion of space tourism for Hollywood A-listers, Asgardia is seeking to boldly launch themselves to the forefront of space residency for a mass audience.

In July, we celebrated the momentous 50th anniversary of the Apollo 11 moon landings, but in reality, we have been celebrating the achievements of that mission every day since. The technological developments of the mission have had huge implications on the ways that we have lived our lives. The lunar drill, created for the mission, revolutionised labour endeavours, leading the way for the creation of cordless, lightweight electric tools. Furthermore, the integration of circuit technology and silicon chips into our consumer technology is now a given in the 21st century. But it was all thanks to the developments of Apollo-associated companies such as Fairchild based in Santa Clara County, California that we enjoy micro-computer chips.

Could you now imagine a world without Silicon Valley? Well, you can thank Apollo 11 for that.

However, the time is to now look forward once again. From the celebrations of Apollo 11, we must recapture that pioneering spirit and continue widescale development. The 21st space race has very much been ignited by the pioneering enterprises of Messrs Branson, Musk and Bezos, with the last few years being undeniably the most transformative for the sector. Soon we will see humans travelling into space as a leisurely activity and not just for scientific research. This means that the boundaries for human exploration effectively cease to exist.

"In July, we celebrated the momentous 50th anniversary of the Apollo 11 moon landings, but in reality, we have been celebrating the achievements of that mission every day since. The technological developments of the mission have had huge implications on the ways that we have lived our lives."

The great achievements of the NASA projects in the 20th century showed that space exploration can be done. Space travel was no longer a fantasy but a realistic prospect. The beauty of private enterprises taking people to space is that they show how it should be done. Space travel can now be luxurious and comfortable. Private enterprise has also led the way in developing reusable rockets. This will prove to drag down the costs of space travel enormously and will soon provide a service that is not just exclusive to the hugely affluent classes in society.

But where does Asgardia fit into this?

Whilst the exploits of the aforementioned gentleman have their own certain ambitions, we believe that none are quite so multi-faceted as Asgardia. On one front, there are scientific developments to create conditions for which space habitation can flourish. One could say that our headline development is to research and create the environment by which Asgardia will be able to facilitate for the first human birth in space within the next 25 years. A particularly large focus of our research and development team is, therefore, to accelerate the developments into creating an environment in which an earth-like gravitational force can be replicated.

Dr Lena De Winne, Head of Information and Communications at Asgardia

Once we have the capabilities to facilitate human conception, we can then continue to develop our next two stages for research and development. These developments are how people will recognise as Asgardia for years to come.

The primary role of Asgardia is to provide a home for humans in space. With plans for low-orbital arks around the earth and then farther out to orbit around the moon, we believe that this ambition really can become a reality. The survival of the human race is dependent on these discoveries too. With technology on Earth that has the potential to destroy such vast numbers of people, it is essential that we have a safeguard in place to protect our species.

In addition to human survival, Asgardia intends to develop technology that will defend Earth from Near-Earth Objects (NEOs). Currently, we are at the mercy of chance and lady luck. Quite often when NEOs pass, we are not aware of them until they are due to pass within the next ten hours. On many occasions, we don't even know about the NEOs until they have actually passed. With our anti-NEO technology, we will be ensuring the survival of the human race on multiple fronts, setting Asgardia apart from the rest of the pack. ■

Dr Lena De Winne
Minister of Information and Communications
Asgardia
Tel: +49 160 758 1684
lena.de.winne@aasgardia.space
https://asgardia.space/en/
www.twitter.com/AsgardiaSpace

CMB Space missions: a window to astroparticle physics

Prof. Nicola Vittorio from Università degli Studi di Roma 'Tor Vergata' gives an absorbing insight into CMB Space missions and why they are a window to astroparticle physics

Input stress[1] on the great goal of modern cosmology: investigating the physics of the early universe. This very ambitious goal requires combined and synergic contributions from astronomy, particle physics and cosmology. These three research areas are progressively converging into a relatively new research field called astroparticle physics, which simultaneously addresses fundamental questions connected from one hand with the elementary particles and their interactions but, on the other hand, with the formation and evolution of the large-scale structure of the universe.

In 2001, the Astroparticle Physics European Consortium (APPEC) was founded to promote cooperation among the members of the European scientific community and coordination among the national (European) scientific agencies. This was (and is) perfectly in line with the need and the effort to build a European Research Area (ERA), as clearly stated in 2011 by the European Council. This is obviously crucial to fully capitalise on Europe's scientific and creative potential.

An ERA Roadmap at EU level was endorsed by the Council in 2015, calling for a limited number of top action priorities. Although transnational cooperation between the Member States has increased along with an improvement of all the indicators for research excellence, there is still much to do. This is why it has been particular timing the presentation of the European Astroparticle Physics Strategy by APPEC the 9th January 2018, in Brussels, Belgium.

The APPEC Recommendations for the 2017-26 address specific scientific issues and updates of long-term scientific strategies, as well as societal issues like global collaboration, community building, gender balance, education, public outreach and relations with industry. Among these recommendations, there is the recognition that: "The future Cosmic Microwave Background (CMB) programme sets the stage for a range of opportunities to link key themes together and provides a potential stepping-stone towards further fundamental discoveries".

Interestingly enough, the properties of the galaxies and their spatial distribution, as observed "here and now", are determined by the physics of the inflation, a period of accelerated expansion occurring in the early Universe just (10^{-36} seconds) after the conjectured Big Bang. Inflation is nowadays considered the paradigm solving some fundamental shortcomings of the hot Big Bang model and, most of all, providing the only self-consistent mechanism able to explain the generation of the primordial seeds out of which (via gravitational instability) all the observed cosmic structures have formed.

The CMB is certainly the most powerful and natural tool to characterise these seeds and to constrain models of particle physics beyond the standard model at energies which will be never reached in laboratory experiments. In particular, tensor perturbations of the space-time metric lead to a primordial gravitational wave background, which imprints a unique pattern (the so-called B-modes) in the polarisation of CMB photons. Therefore, the primary scientific exploitation of CMB B-mode detection will aim to a definitive probe of the inflation paradigm and, hopefully, to elucidate the physical mechanisms behind it.

In addition to this, the gravitational lensing of CMB photons due to the large-scale matter distribution will provide stringent information on the distribution of dark matter and, possibly, on the masses of neutrinos. The comparison between the neutrino properties inferred from cosmological measurements and those determined in laboratory experiments is likely to open a new window on our physical modelling of the micro- and macro-cosmos.

To discover the secrets hidden in the B-modes of the CMB, it is necessary to combine observations from space and from the ground. The ongoing and forthcoming ground-based CMB experiments[2] use large detector arrays and reach high angular resolution.

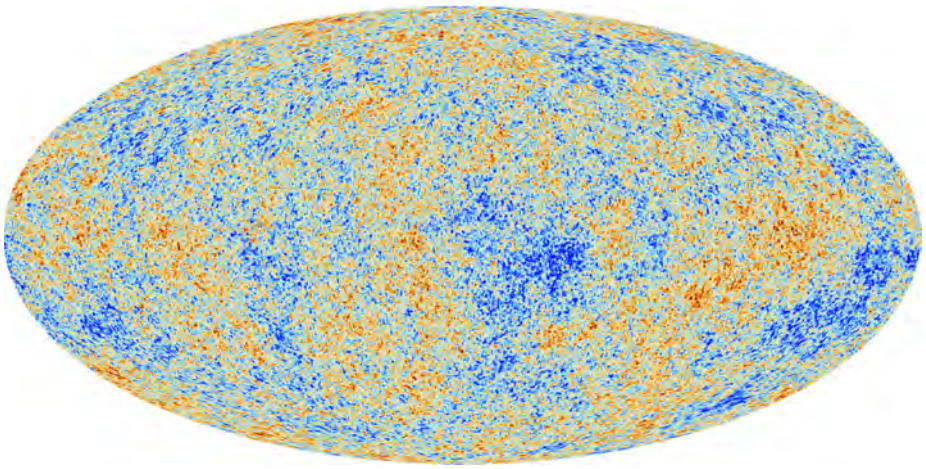


Image: http://www.esa.int/spaceinimages/Images/2013/03/Planck_CMB

The CMB is the oldest light reaching us "here and now". The ESA/Planck observations of this light show tiny intensity fluctuations that bring information on regions that had slightly different densities when the universe was 380 000 years old. The existence of these regions explains the large scale structure of the universe we observe today

Space-borne CMB measurements are not limited by the atmosphere and can probe a wide frequency range to provide an effective foreground subtraction to reveal the truly primordial B-modes induced by the primordial gravitational wave background.

The last space experiment dedicated to CMB observations is the ESA/Planck mission, which has created a CMB community in Europe with a unique expertise in space-borne CMB research. After the completion of Planck and the forthcoming Planck Legacy release, European CMB researchers have continued to play leadership roles in a number of suborbital efforts – both in Europe (e.g., Qubic, LSPE, Pilot) and elsewhere (e.g., by collaborating with the ground-based S4 program) – but still looking for a shared, major European experimental effort.

The European CMB community has also recognised the need and the urgency for a new space mission. There was quite a strong R&D effort in Europe in new technologies for the next generation CMB experiments and a proposal for a Core mission submitted to ESA has been, unfortunately, rejected. Therefore, LiteBIRD (Lite satellite for the studies of B-mode polarisation and Inflation from cosmic background Radiation Detection) – a JAXA's strategic large mission candidate in Phase-A1 (concept development) – appeared to the European CMB community a natural and logical continuation of these Europe-led efforts.

At the national level, there is an interest to contribute to LiteBIRD from CNES in France, from both the UK Space Agency (UKSA) and the UK Science and Technology Facilities Council (STFC) and from the German Aerospace Center (DLR). The Italian Space Agency (ASI) has already founded the participation of the Italian CMB community to the LiteBIRD Phase A1 study, which will end by the end of this year.

Further interest at the European level has been manifested by Spain, the Netherlands and Finland, along with Sweden. To facilitate a coordinated effort of the European community during the Phase A1 of the LiteBIRD experiment, there is the willingness to constitute a European Consortium. The governance structure of this Consortium will be finalised during the forthcoming Turin Meeting (8th-9th February 2018). This structure will be revised once the LiteBIRD mission will be approved and the so-called Phase B will start, early in 2019.

The participation of the European CMB community in LiteBIRD was solicited by a formal letter of the ISAS/JAXA Director-General. A potential junior partnership of ESA on the JAXA-led mission LiteBIRD could be realised through a Mission of Opportunity (MoO), if there is a clear scientific return to ESA's scientific community. However, ESA cannot approve a MoO before LiteBIRD is formally selected by JAXA.

So, while there is the need of not dispersing knowledge and skills acquired with the ESA/Planck mission, the formal selection from JAXA of the LiteBIRD mission seems to be the appointment not to be missed by the CMB European community.

See the link to my last book here, which was published in late 2017.

1 Open Access Government May 2017, pp 102-103

2 Open Access Government August 2017, pp. 182-183

Prof. Nicola Vittorio
Università degli Studi di Roma 'Tor Vergata'
Tel: +39 (06)72 594 581
nicola.vittorio@uniroma2.it
http://www.nicolavittorio.eu/en
www.web.uniroma2.it/home/newlang/english
www.cosmosnet.it/

A glimpse at astronomical sciences in the U.S.

Here, we unveil the sterling efforts of the National Science Foundation to further astronomical sciences in the U.S.

Astronomical Sciences (AST) is a branch of the U.S National Science Foundation (NSF) focusing on funding and supporting scientists doing basic research within the fields of astronomy and astronomical sciences. The NSF was created in 1950 by congress as they stated that this type of support is a primary driver of the U.S. economy. It also vastly enhances the security of the U.S. and advances knowledge that sustains global leadership in the sciences.

The AST is part of the Directorate for Mathematical and Physical Sciences (MPS)- another branch of the NSF. Other divisions include the Divisions of Chemistry, Materials Research, Mathematical Sciences, and Physics. These agencies often collaborate to achieve their set mission which is "to harness the collective efforts of the mathematical and physical sciences communities to address the most compelling scientific questions, educate the future advanced high-tech workforce, and promote discoveries to meet the needs of the Nation."[1]

The specific aim of the AST is to provide facilities and funding U.S. astronomical researchers. This is to ensure that U.S. astronomical research is to a high standard and to encourage understanding of the astronomical sciences to members of the public and politicians alike.

> "We have never seen anything like 'Oumuamua' in our solar system. It's really a mystery still," said Knight."

"Basic research" is defined by the NST as scientific research that improves or expands upon pre-existing scientific theories. For instance, recent research by the AST has explored Einstein's 100-year-old theory that light is deflected by "extremely massive objects."[2]

A team of astronomers funded by the AST discovered that Einstein was correct, stating: "Our observations are consistent with Einstein's theory of general relativity. However, his theory is definitely showing vulnerability. It cannot fully explain gravity inside a black hole, and at

some point we will need to move beyond Einstein's theory to a more comprehensive theory of gravity that explains what a black hole is."[3]

As well as testing previous scientific research the AST has also looked into one of the more prominent scientific news stories of this decade. The 'Oumuamua'[4] asteroid was the first known interstellar object to visit our solar system and viewed by an NSF funded observatory at the University of Hawaii.

> "The specific aim of the AST is to provide facilities and funding U.S. astronomical researchers. This is to ensure that US astronomical research is to a high standard and to encourage understanding of the astronomical sciences to members of the public and politicians alike."

The object had odd and irregular characteristics: it was cigar-shaped and resembled both a comet and an asteroid. This was extremely unusual which led some observers to question whether or not it was an alien spacecraft. However, an international team of astronomers part-supported by the AST provided evidence that this theory was far-fetched. Scientist Matthew Knight stated, "We have never seen anything like 'Oumuamua' in our solar system. It's really a mystery still," said Knight. "But our preference is to stick with analogs we know, unless or until we find something unique. The alien spacecraft hypothesis is a fun idea, but our analysis suggests there is a whole host of natural phenomena that could explain it."[5]

Now, the NSF is funding a new telescope called the Large Synoptic Survey Telescope (LSST), which has been designed to detect more objects like the Oumuamua. This telescope will be active by 2022 and is set to be one of their most advanced telescopes yet.

The NSF and AST also built the Green Bank Telescope, which is located in West Virginia and started operating in 2001. The telescope is currently the world's largest fully steerable radio telescope. However, as of 2016, the telescope is now operated by a partially funded group known as the Green Bank Observatory. This is because the NSF and AST are gradually decreasing the funding for the Green Bank Telescope from 2016-2019. They are now still involved in the project but supplying less financial support. ■

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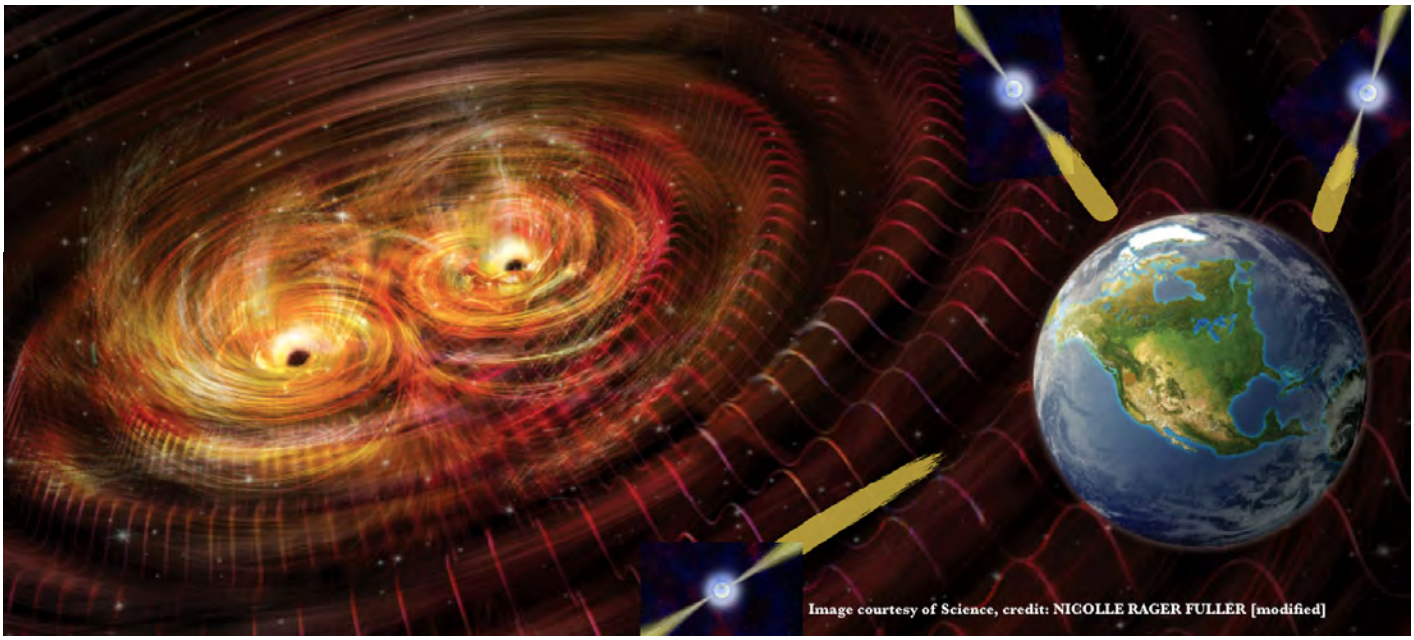

Image: © Nicolle Rager Fuller

The journey towards nanohertz gravitational-wave astronomy

The new era of gravitational-wave astronomy is explored here by Miguel Holgado, PhD, Candidate at the Department of Astronomy, the University of Illinois at Urbana-Champaign

Einstein's Theory of General Relativity predicts the existence of gravitational waves (GWs), ripples in spacetime produced by accelerating massive objects. The era of GW astronomy began with the Laser Interferometer Gravitational-wave Observatory (LIGO) detection of GWs from the inspiral and merger of two heavy stellar-mass black holes. Being able to observe GWs has opened up new ways to answer open questions in astrophysics and other areas of science that were not possible beforehand. LIGO, however, is only sensitive to GWs at frequencies of order tens of hertz to kilohertz, where binary neutron stars and stellar-mass binary black holes merge. Different detectors are, thus, needed in order to detect GWs at lower frequencies.

The multi-band frequency spectrum of gravitational waves

GWs may span a wide range of frequencies. The larger the mass of black holes, the lower the frequency. This is because the size of the black hole increases with its mass. The larger the length scale of a black-hole binary, the longer the corresponding orbital period. Longer orbital periods correspond to lower frequencies. In the future, more frequency bands of the multi-band GW spectrum are expected to be opened up, with the nanohertz frequency band already expected to develop considerably within the next 5-10 years.

"Being able to observe GWs has opened up new ways to answer open questions in astrophysics and other areas of science that were not possible beforehand."

What produces nanohertz gravitational waves?

Nanohertz frequencies correspond to binary orbital periods of years to decades, much longer than the millisecond timescales that LIGO is sensitive to. The loudest sources that are

expected to produce nanohertz GWs are supermassive black-hole (SMBH) binaries with orbital periods of years to decades. This is because SMBHs are the most massive black holes in the Universe, thus, corresponding to large GW amplitudes. Almost every galaxy is expected to host a SMBH at its centre. Given that we have seen that galaxies can merge with each other, do the SMBHs of each galaxy merge as well? If so, then such SMBH binaries should produce GWs as they inspiral. SMBH binaries at nanohertz frequencies decay on timescales longer than human timescales. Thus, the primary expected signal for nanohertz GW astronomy is a stochastic background, a combination of the entire cosmic SMBH binary population across the entire sky.

"Next-generation telescopes will also continue to observe current SMBH binary candidates and are expected to find even more as well. The future is, therefore, both bright and loud for nanohertz GW astronomy."

How can we detect nanohertz gravitational waves?

Pulsar timing arrays (PTAs) are a particular type of GW detector that is sensitive to GWs with frequencies of order nanohertz, which are much lower compared to LIGO's sensitivity at tens of hertz to kilohertz. Pulsars are rapidly spinning neutron stars that emit radio-wave pulses at regular intervals, with timing precision comparable to atomic clocks. When a GW passes through the Earth and a distance pulsar, the arrival times of the pulses will be shifted due to the stretching and squeezing of space-time. The main smoking gun for a detection is that the PTA as a whole behaves in a manner consistent with what GWs would produce. Any sky pattern of pulses from a PTA that is not consistent with GWs allows for other signal behaviours to be ruled out.

The latest developments

So far, PTAs have not yet detected the nanohertz GW background and instead have been placing even more stringent upper limits over time. Even though a detection has yet to be made, the upper limits have actually proven to be of astrophysical interest. The most optimistic predictions for what the background might be are starting to be ruled out. In addition, telescopes have been finding bright galactic nuclei that appear to have a periodic behaviour, which is sometimes interpreted to be due to a SMBH binary. PTA upper limits have shown, however, that not all candidates can be real binaries. Otherwise, these candidate binaries would produce a GW background that PTAs would have already detected.

What will we learn from a detection?

A detection of the nanohertz stochastic GW background will provide new insights about the cosmic SMBH binary population that were not possible beforehand. Measuring the amplitude of the background and the shape of its frequency spectrum will tell us more about how SMBH binaries interact with their environments, including the gas and stars that are thought to be in the vicinity of the binary. Even after a detection of the background, PTAs can still operate during the following years and decades in order to better characterise the background in addition to making a skymap of the nanohertz GW background. If there happens to be a detection of a single SMBH binary that is louder than the background, then such a source could be followed up by telescopes to look for an electromagnetic counterpart and its host galaxy. With these counterparts, a better understanding of how the properties of the binary correlate with the electromagnetic emission and the host-galaxy properties is possible.

What can we expect in the next 5-10 years?

PTAs are poised to detect the nanohertz stochastic GW background from the cosmic SMBH binary population. Pulsar observations will continue well into the future and new pulsars are continually being added to the current array. These efforts will improve upper limits on the GW background and lead closer and closer towards a detection. Next-generation telescopes will also continue to observe current SMBH binary candidates and are expected to find even more as well. The future is, therefore, both bright and loud for nanohertz GW astronomy.

NANOGrav

A. Miguel Holgado
PhD, Candidate
Department of Astronomy,
University of Illinois at Urbana-Champaign
holgado2@illinois.edu

Nanomaterials: A focus on the laser ablation in liquid environment (LALE) technique

Cecilia Van Cauwenberghe from Frost & Sullivan's TechVision Group focuses on nanomaterials by looking at the challenges and opportunities around the laser ablation in liquid environment (LALE) technique, including an overall perspective

Laser ablation in liquid environment (LALE) has been used as a straightforward technique to build a broad spectrum of nanostructured materials or nanomaterials. This singularly versatile technique enables to overcome the main challenges faced when the mechanism of synthesis remains as the interaction between the laser beam, the irradiated solid target and the liquid environment (Abdelghany et al., 2018).

Indeed, a wide range of nanostructured magnetic materials can be prepared by using new synthesis pathways based on LALE technique, taking into consideration that the precursors used come directly from the ablation of a solid target and the liquid environment. The utilisation of LALE technique during the synthesis process necessarily involves non-equilibrium conditions. High temperatures and pressures, above 100 Kelvin and 100 Pascal, respectively, are generated as a consequence of the interaction between the pulsed laser beam and the solid target. In fact, the micro and nanostructure of the prepared materials strongly depend on the fluency of the laser beam on the target, as well as, the solvent utilised, in addition to the concentration of reactants in the liquid. The laser beam directly influences the size distribution of the synthesised particles.

The concerns broadly addressed

Like many other synthesis techniques used to build nanostructured materials, the LALE technique also presents some drawbacks. First of all, it is important to highlight that during the chemical synthesis, metal precursors, reductant agents and stabilising chemicals, are present all together in the synthesis solution with the aim to ensure stable chemical-synthesised colloids. Nevertheless, many of these products and/or byproducts may produce adverse effects on human health. Standards and regulations establish that such potentially harmful chemicals must be separated and removed from the final nanocolloids before their final utilisation.

Overall, LALE technique presents the lower risk and environmental impact, due to the fact that both metal precursors and reductants are not needed. Moreover, nanocolloids offer higher levels of purity in comparison with conventional chemical synthesis methods (Sportelli et al., 2018). The technique not only avoids the utilisation of reductants but also can fragment metal targets without recurring to capping agents (Akter et al., 2018). This processing feature makes the LALE technique intrinsically safer than conventional methods by dramatically reducing the risk of contamination of the nanocolloids.

"The utilisation of LALE technique during the synthesis process necessarily involves non-equilibrium conditions. High temperatures and pressures, above 100 Kelvin and 100 Pascal, respectively, are generated as a consequence of the interaction between the pulsed laser beam and the solid target."

Furthermore, in the use of the obtained nanostructured materials for antimicrobial applications, nanoparticles generated using the LALE technique demonstrate a lack of ligands and typical stabilisers on their surface, hence exhibiting higher reactivity and antimicrobial effects in comparison other chemicals (Kaphle et al., 2018). Even a step beyond, nanoparticles created based on LALE technique can be conjugated in situ with biomolecules, thus undergoing a more efficient performance than nanomaterials conjugated ex situ (Sportelli et al., 2016). Conversely, the main drawbacks of LALE technique are related to high investment and operative costs due to the utilisation of a particularly expensive laser system, as well as, the considerable amounts of energy required to obtain good ablation efficiency.

Final remarks

Even when exhibiting some disadvantages in terms of costs and operation, so far, laser ablation in liquid environment (LALE) constitutes the most efficient and straightforward technique to create nanostructured materials in a safe and effective manner for both human health and environment. ■

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Cecilia Van Cauwenberghe, PhD, MSc, BA
Associate Fellow and Senior Industry Analyst
TechVision Group, Frost & Sullivan
cecilia.vancauwenberghe@frost.com
ww2.frost.com
www.twitter.com/Frost_Sullivan

Size of nanoparticles from laser ablation: Lessons from wet-chemical synthesis

Here, Laser Ablation in Liquid (LAL) is explored as means to understand the shapes and sizes of nanoparticles

The unique optical, electronic, and catalytic properties of metal nanoparticles as compared to their bulk metal counterparts depend strongly on the nanoparticles' sizes and shapes. For instance, nanoparticles of noble metals such as gold and silver exhibit a localized surface plasmon resonance (LSPR) arising from the collective oscillations of the free electron cloud, which is sensitive to the nanoparticle size, shape, and composition. As a result, controlling the size and shape of gold and silver nanoparticles makes it possible to tune their optoelectronic properties for applications such as photothermal therapy, biosensing, and photocatalysis.

Decades of research into wet-chemical synthetic routes to noble metal nanoparticles have led to the discovery of nanoparticle morphologies ranging from atomically precise gold nanoclusters with as few as 13 atoms to larger spherical, cubic, octahedral, and triangular prism gold and silver nanostructures. This exquisite level of control over nanoparticle morphologies is typically exerted through a combination of two strategies: controlling the nanoparticle growth kinetics through tuning parameters such as reducing agent concentration, temperature, solvent, and salt additives; and adding organic surfactants or polymers that attach to the nanoparticle surfaces as ligands and prevent excessive growth. However, these strategies often require excess quantities of reducing agents and surfactants, which produces significant amounts of chemical waste. Moreover, organic ligands must be removed for certain applications due to their toxicity or because they block catalytically active sites.

> "The laser-induced decomposition of water produces two important reactive species that can reduce the tetrachloroaurate ion: hydrated electrons and hydrogen peroxide, which is formed from the recombination of hydroxyl radicals."

Laser Ablation in Liquid (LAL) methods have emerged as promising routes to colloidal nanoparticles that have myriad advantages over wet-chemical methods. For instance, laser processing can be carried out under ambient conditions and requires no toxic chemical reducing agents, thus minimising chemical waste generation. Moreover, laser processing produces colloidally stable noble metal nanoparticles without organic capping ligands, which yields uncoated "naked" nanoparticles particularly suited to catalytic and biomedical applications. However, the absence of capping agents makes producing narrow nanoparticle size distributions with LAL challenging. For instance, gold nanoparticles (AuNPs) produced by "top-down" laser ablation of a gold target in pure water typically exhibit broad size distributions of spherical particles ranging from ~5 – 100 nm or larger. Our laboratory's work found that "bottom-up" laser-induced reduction of aqueous tetrachloroaurate salt precursor to AuNPs also produces broad particle size distributions from ~3 – 30 nm or larger, depending on the reaction conditions[1-4].

From nearly the beginning of top-down LAL investigations in the early 2000's, investigators have added organic capping agents used in wet-chemical synthesis such as sodium dodecyl sulfate (SDS) or poly(ethylene glycol) (PEG) to the water solvent prior to immersion of the gold target. This strategy effectively produces predominantly sub-10 nm AuNPs from top-down LAL. For bottom-up AuNP synthesis via tetrachloroaurate reduction, we found that adding PEG to the solution forms AuNPs as small as 3.9±0.7 nm[1], but producing such small and monodisperse AuNPs without PEG had remained elusive[2,3].

To control AuNP sizes in bottom-up tetrachloroaurate reduction without capping agents, we turned to the other popular wet-chemical strategy: controlling the reaction kinetics by manipulating the availability of reducing agents in solution. The laser-induced decomposition of water produces two important reactive species that can reduce the tetrachloroaurate ion: hydrated electrons and hydrogen peroxide, which is formed from the recombination of hydroxyl radicals. Electrons are particularly strong reducing agents, and our laboratory found that hydrogen peroxide accelerates the reduction of

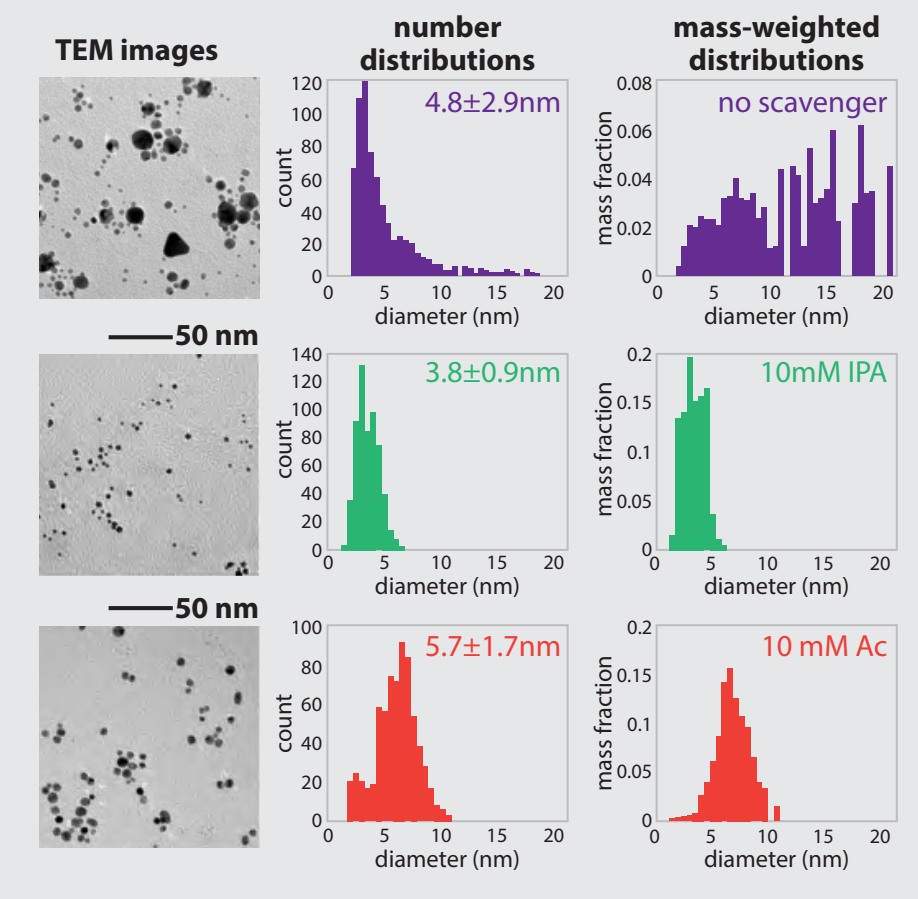

Figure 1

tetrachloroaurate when AuNPs are already present through an autocatalytic growth mechanism[1-4].

We reasoned that hydrogen peroxide-induced autocatalytic AuNP growth was to blame for the difficulty in controlling AuNP size distributions. To block this detrimental action of hydrogen peroxide, we added the well-known hydroxyl radical scavengers isopropyl alcohol (IPA) and sodium acetate (Ac) to the tetrachloroaurate solution to prevent hydrogen peroxide formation. With sufficient amounts of added scavengers, the autocatalytic AuNP growth was significantly slowed and monodisperse AuNPs as small as 3.8±0.9 nm were produced (Figure 1)[4]. In particular, the addition of scavengers completely eliminated the formation of nanoparticles larger than 10 nm, as compared to the no-scavenger product that exhibits more than 50% of the Au mass in >10 nm particles.

These results demonstrate that controlling the availability of reducing agents produced by laser-induced solvent decomposition enables exceptional control over both the reaction kinetics and the resulting particle size distributions in bottom-up LAL. Combined with earlier results demonstrating the efficacy of capping agents in controlling nanoparticle sizes both for top-down and bottom-up LAL, it is evident that applying the lessons of wet-chemical synthesis can significantly improve the quality of LAL-synthesized nanoparticles. Our group is pursuing additional investigations into understanding and manipulating reaction kinetics in bottom-up LAL that will equip the LAL community with tools needed to exert improved control over nanoparticle sizes, making them suitable for practical applications.

> "...laser processing can be carried out under ambient conditions and requires no toxic chemical reducing agents, thus minimising chemical waste generation."

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VIRGINIA COMMONWEALTH UNIVERSITY

Katharine Moore Tibbetts
Assistant Professor
Virginia Commonwealth University
Tel: +1 804 828 7515
kmtibbetts@vcu.edu
https://chemistry.vcu.edu/people/faculty/tibbetts.html

Getting your chemistry right

Prof Colin J Suckling OBE DSc FRSE from the Department of Pure & Applied Chemistry, at University of Strathclyde, explains the importance of getting your chemistry right

A lot of people, especially in media circles, respond only to what is branded as new without considering significance including making new things possible. It is true that the bases of many of the core sciences were established a long time ago, in the case of mechanics and hydraulics, for example, centuries ago at the beginning of written history. In the case of my fields of interest, the scientific principles of chemistry go back to late 18th and through the 19th and 20th centuries, a comparatively short time. The point about this remark is that new knowledge rarely comes from nothing; it soundly based on accumulated prior information and understanding. I follow happily a dictum from the Lord Todd of Trumpington, Nobel Prize winner and former Chancellor of the University of Strathclyde, which runs: 'Chemistry is the Queen of Sciences. Get your chemistry right and everything else follows'. This is a snappy way of reminding us that chemistry is a science that creates its objects for study and, most importantly, objects that are components of useful materials and devices.

Lord Todd's field of study was the chemical synthesis and properties of a class of compounds known as nucleotides, which includes components of DNA. His work established the basis for the chemical synthesis of nucleotides and related compounds that in other people's hands eventually led to understanding the genetic code, to the chemical synthesis of DNA itself and to many procedures fundamental to molecular biology. Todd's Nobel Prize-winning research in the 1940s and 1950s contributed to making a great deal of contemporary science and technology possible. One of the features of the field in which he worked is the enormous variety of chemical compounds that were investigated based upon a relatively small number of central patterns. This is a characteristic of what is called 'heterocyclic chemistry', which simply means the chemistry of compounds that contain rings of atoms with at least one element other than carbon. It is one of the core fields of chemistry to which I referred in the paragraph above and its sheer versatility and flexibility make it central to modern technologies as diverse as television screens and new drugs (see my e-book published by Open Access Government: 'Why does heterocyclic chemistry matter?'). It's important to make new things happen by the intelligent and wise application of science and heterocyclic chemistry is one major field that makes this possible.

With this background then, it's no surprise that much of the research that we carry out at the University of Strathclyde has heterocyclic chemistry at its core. In my own laboratory, we are concerned with the discovery of new anti-infective drugs for treating both human and animal populations and the discovery of new

Prof Colin J Suckling

immunomodulatory and anti-inflammatory compounds. In both of these projects, we have taken approaches that are not typical of the way the pharmaceutical industry approaches drug discovery. The big pharma paradigm is to find a compound that provides an improvement for the patient (not necessarily a cure) by targeting a single component of the pathology that is causing the disease, be it an infectious agent (bacterium, fungus, parasite, or virus) leading to a single measurable effect; put simply it's one drug, one target, one effect. There are good reasons for working in this way, mostly to do with the minimisation of risk, but it's not the only way to advance drug discovery. Indeed, it can be argued that the big pharma paradigm limits advances. In our

discovery programmes at the University of Strathclyde, therefore, we have adopted approaches that industry would consider too risky. In both of our projects mentioned, heterocyclic chemistry and its inherent flexibility have played a major role.

I'll illustrate this for our anti-infectives programme which is the most advanced and has heterocyclic chemistry is at the heart. Our compounds synthesized at the University of Strathclyde being developed for antibacterial, antifungal and antiparasitic applications belong to a class of compound known as minor groove binders (S-MGBs) that engage DNA to kill the infectious agent in ways yet to be worked out in detail. Our best compounds are very potent but somewhat surprisingly, are not toxic to mammalian cells and more surprisingly still are in general effective in mouse models of disease without evidently causing adverse effects in the mouse. This selective toxicity is what is needed in an anti-infective drug: kill the disease-causing agent but not the host. Moreover, because of the way S-MGBs work it has proved impossible so far to generate resistance to our S-MGBs in laboratory experiments, a very important advantage for a drug that would be widely used in the field over many years.

That we can achieve these things is down to the flexibility of heterocyclic chemistry whereby we can make small, subtle changes to the structures of our S-MGBs whilst maintaining the essential properties of binding to DNA and killing bacteria, fungi or parasites. It's unpredictable what a small change in structure will do. For example, we have found that the addition of just one carbon atom as a methyl group improves the potency of an S-MGB by as much as tenfold. Small changes can also influence the physical-chemical properties of S-MGBs so that active compounds suitable for a variety of routes of delivery, for example, injectables, non-absorbed oral formulations, or topically active creams can be obtained. All of these properties are controlled by the chemical structure of our S-MGBs so that we can truly connect with Lord Todd's dictum: 'Get your chemistry right and everything else follows'.

> "' Chemistry is the Queen of Sciences. Get your chemistry right and everything else follows'. This is a snappy way of reminding us that chemistry is a science that creates its objects for study and, most importantly, objects that are components of useful materials and devices."

University of Strathclyde Glasgow

Prof Colin J Suckling OBE DSc FRSE
Research Professor of Chemistry
Department of Pure & Applied Chemistry,
University of Strathclyde
Tel: +44 (0)141 548 2271
www.strath.ac.uk/chemistry

Promoting and encouraging research in the chemical sciences

The National Science Foundation's Division of Chemistry is placed under the spotlight here, with a focus on their Critical Aspects of Sustainability (CAS) program that sets out to promote and encourage research in the chemical sciences

The National Science Foundation (NSF) was set up by Congress in 1950, "to promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defence." [1] This article will briefly focus on the work of the Division of Chemistry (CHE) within the NSF who set out to support innovative research in the chemical sciences. Integrated with education, they believe this aim can be achieved with strategic investment in developing a globally engaged chemistry workforce that reflects the diversity of the U.S. CHE's values includes the vital role that fundamental scientific research plays to benefit society. Looking ahead, another value they hold dear is empowering future generations in the fields of science and engineering. [2]

In a recent edition of Open Access Government, Carol Bessel and Melissa Olson from the Division of Chemistry (CHE), revealed their thoughts on the kind of chemistry projects CHE are involved with.

"CHE actively solicits and funds projects that design and develop sustainable chemistry pathways from synthesis to recycling; advance algorithms and novel qubit structures for quantum computing; accelerate and complement chemical discovery with data mining and artificial intelligence (AI); and seek to understand and engineer the biochemistry governing life processes such as in synthetic biology, epigenetics and studies of the microbiome." [3]

In recent CHE news, we see that the Critical Aspects of Sustainability (CAS) program is well promoted on the CHE's website. "This program seeks to support basic research through core disciplinary programs aimed at improving the sustainability of resources for future generations while maintaining or improving current products in order to offer technologically-advanced, economically competitive, environmentally-benign and useful materials to a global society."

Also, CAS seeks to support basic research through core disciplinary programs targeted improving the sustainability of resources for future generations while improving or maintaining or current products to offer economically competitive, technologically-advanced and environmentally-benign and useful materials for a global society.

We take this opportunity to wish the program well in their future endeavours as they welcome research proposals that are supported by the divisions taking part that address a wealth of topics such as Chemical Synthesis (SYN), Chemical Measurement and Imaging (CMI), Solid State and Materials Chemistry (SSMC), Biological and Environmental Interactions of Nanoscale Materials (BioNano) and Environmental Chemical Sciences (ECS). [4]

In conclusion, the work of CHE just tells a small part of the NSF's work but it clearly illustrates their aim from the outset, "to promote the progress of science." ■

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editorial@openaccessgovernment.org
www.openaccessgovernment.org
https://twitter.com/OpenAccessGov

Chemistry: Sustainable water purification solutions from underutilised biomass

Benjamin Hsiao, Distinguished Professor from Stony Brook University provides an excellent overview of an aspect of chemistry that concerns sustainable water purification solutions from underutilised biomass

The demand for low-cost water purification technologies has become a pressing issue due to rapid population growth in the world. At the turn of the last millennium, we already had over 1 billion people lacking access to safe drinking water and basic sanitation and nearly 4,000 children under the age of five dying each day[1]. This situation has and will continue to worsen with the projected increase in population. Current water purification technologies, often relying on relatively expensive systems and synthetic materials, are non-sustainable for the poorest communities in the most water-distressed regions, where these communities are expanding the fastest. It is imperative that we break the paradigm of seeking solutions from existing technologies and instead explore new avenues for sustainable solutions that, as of yet, are unavailable.

We argue that one possible solution to tackle the problem of 'affordable and sustainable' is to use abundant and underutilised biomass as a source for extracting functional nanostructured cellulosic materials, or nanocellulose, for water purification through effective and low-cost means. Cellulose is the most abundant natural polymer on earth. Its annual production is in the order of 7.5×10^{10} tonne[2], which is about 200 times that of the annual plastic production in the world. Cellulose is naturally produced by all higher plants, as well as by a wide range of varying bacteria, algae and fungi, so virtually any plant (wooden or non-wooden) can be used to extract nanocellulose. However, the general consensus is that non-wooden plants usually have a lower lignin content than wooden plants, thereby making them easier to delignify with the simplest nanocellulose extraction process.

Biomass has already been used extensively in various water treatments. The most well-known example is activated carbon, which can be produced by a

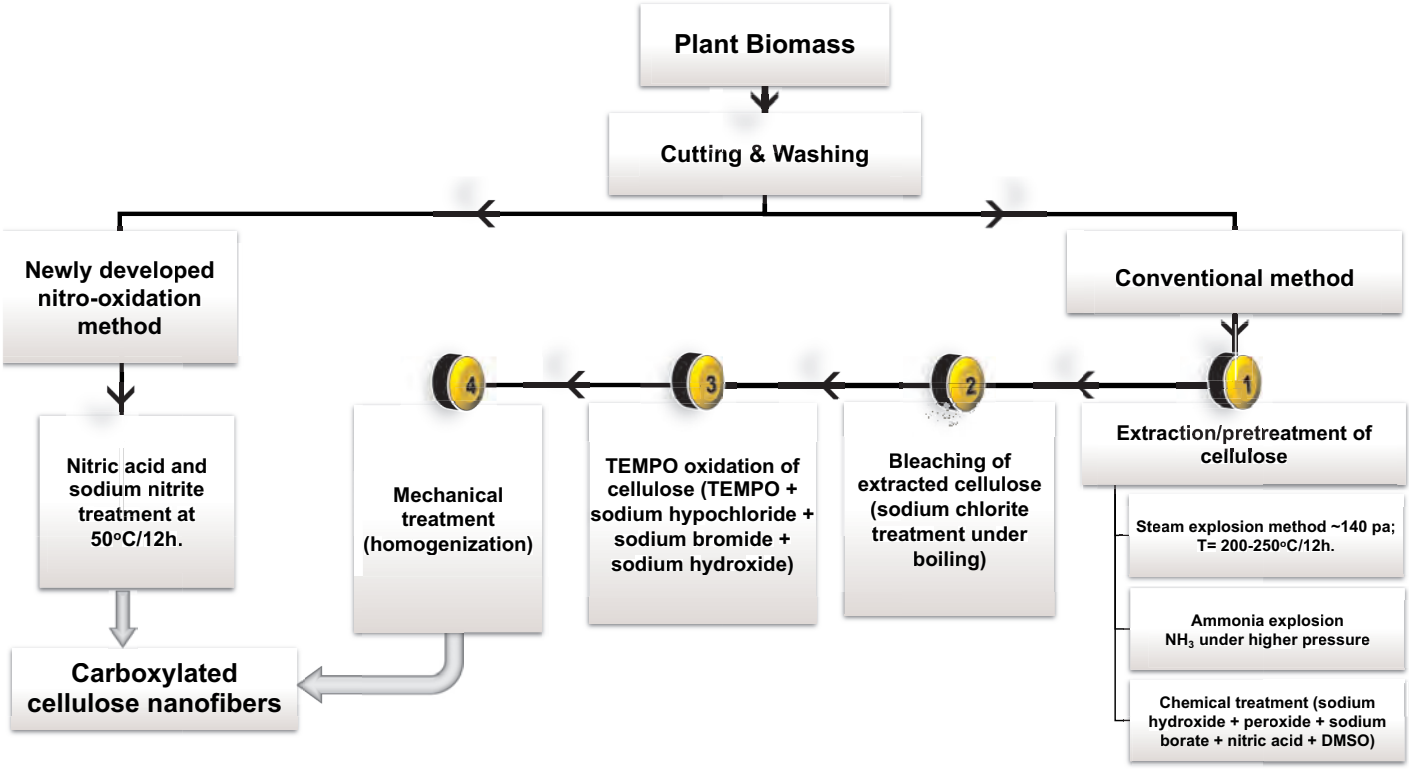

Figure 1. Process diagram comparing the conventional TEMPO oxidation and nitro-oxidation methods to extract nanocellulose from untreated biomass

variety of physical (e.g. thermal) and chemical processes.[3] Activated carbon materials are usually in the mesoporous or particulate forms and they are effective adsorbents for removing many contaminants, such as volatile organic compounds (taste and odour), synthetic organic chemicals and even some mineral ions from water. From an economic standpoint, the denser the biomass components, such as hard wood and coconut tree nut, the more suitable a source for making activated carbon.

Recently, nanocellulose has also been shown as an effective sportive material with adsorption capacity often better than activated carbon for heavy metal removal from water because of the large surface area and functional sites.[4] It is, thus, sensible to consider the use of nanocellulose, extracted from underutilised biomass sources, such as agriculture residues and invasive species that are mostly non-wooden plants, for water remediation. Furthermore, nanocellulose can be used as a barrier material to construct highly permeable water filtration membranes (e.g. microfiltration, ultrafiltration and nanofiltration) with superior properties (e.g. higher permeance and lower fouling) over commercial membranes.[5] Hereafter, we discuss three recent developments in nanocellulose technologies for water purification: nanocellulose extraction, nanocellulose adsorbents and nanocellulose membranes. Continuing advances in these technologies can lead to the realisation of our vision to provide low-cost and sustainable water purification solutions for the communities in most need.

Low-cost nanocellulose extraction

Nanocellulose, such as defibrillated cellulose nanofibers (CNF) and cellulose nanocrystals (CNC), as well as partially defibrillated microfibers, can be extracted from any biomass containing cellulose. Currently, commercially available nanocellulose extraction processes are mainly based on technologies developed for using wooden plants in papermaking. These processes involve multiple steps such as pulping to convert wood into cellulose fibres and mechanical/chemical treatments to defibrillate the fibres. Suitable chemical treatments are particularly important as the resulting nanostructured surface can carry negatively charged ions, ideal to adsorb many positively charged contaminants (such as toxic metals). Recently, a simple nitro-oxidation method has been demonstrated in our laboratory that can successfully prepare nanocellulose directly from raw biomass (jute, spinifex grass and bamboo) with a significant reduction in energy, water and chemical consumption.[6] (Figure 1). As the logistics of collection, transportation and decortication for biofuel production are being addressed to deal with agricultural residues, the developments of new and simple chemistries, such as nitro-oxidation which can extract nanocellulose from

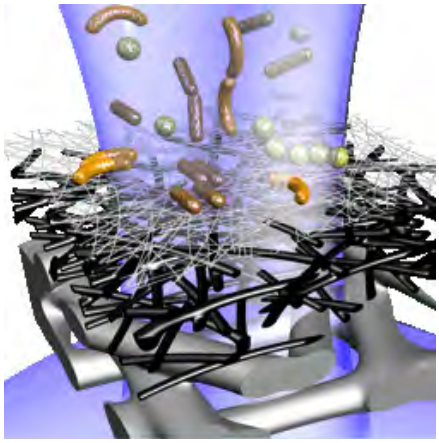

Figure 2. Schematic diagram of ultrafiltration nanofiber membranes with hierarchical fibre diameters from microns to nanometres

vastly underutilised non-wooden plants in a cost-effective manner, are definitely within our reach.

Nanocellulose adsorbents

Nanocellulose is an effective sportive material because the surface cellulose chains are chemically modified to include carboxylate groups (-COO^-) making them highly attractive to bind to heavy metal ions (e.g. lead, cadmium, mercury, chromium and uranyl). The maximum adsorption capacity of nanocellulose for heavy metal ion removal can be several times higher than those of the most effective adsorbents reported in the literature. The metal adsorbed nanocellulose flocs can also be easily removed by simple and inexpensive gravity-driven microfiltration or decanting methods, thus reducing the significantly added cost issue related to the removal of secondary contaminants.

Besides toxic metal ions, nanocellulose is also effective to remove organic contaminants, including ammonium ions. This property is particularly useful for nitrogen removal, the number one issue in wastewater treatments and land-based aquaculture, where the ammonium adsorbed nanocellulose compound can be used directly as plant/crop fertilisers. Such an application will provide a new food-water-energy nexus to greatly improve the efficiency of the nitrogen cycle.

Nanocellulose membranes

Membrane technology remains the most energy-efficient method to remove contaminants (micron size particles to angstrom size hydrated ions) from water in large scale. Recently, nanofiber membranes based on nanocellulose, have exhibited better filtration performance (e.g. higher flux and lower fouling) than commercial membranes in microfiltration, ultrafiltration and nanofiltration (Figure 2).[7] Better flux means less time to filter the same amount of water, which, in turn, decreases energy consumption and increases cost efficiency. Lower fouling means having the ability to minimise clogging of the membrane pores by foreign matter, such as oil, detergents and biomacromolecules during filtration.

We believe the current state of nanocellulose membrane technologies is only in its infancy stage and the field will grow rapidly as these technologies can take full advantage of the knowledge base on paper and packaging processes even though filtration membranes have very different property requirements from paper products, such as good wet strength, high porosity and controllable pore size. The combined nanocellulose membrane and adsorbent technologies not only can provide sustainable solutions to deal with many off-the-grid drinking water challenges, but also will offer new platforms to advance cost-efficient water treatment processes in large industrial scale.

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Stony Brook University

Benjamin Hsiao
Distinguished Professor
Stony Brook University
Tel: +1 631 632 7793
Benjamin.hsiao@stonybrook.edu
www.hsiaoglobal.org

Chemistry: Enzyme activity assays for disease diagnosis

Contributing scientists, Shu Jia, Jay Sibbitts, Abby Kreznor, Dr Obdulia Covarrubias-Zambrano, Jose Covarrubias, Dr Madumali Kalubowilage, Stefan Bossmann, and Christopher Culbertson from Kansas State University, share their thoughts around the field of chemistry, focussing on enzyme activity assays for disease diagnosis, novel drug development validation and nanoparticles

Enzyme activity assays can be used for disease diagnosis and novel drug development validation. Understanding how well a key enzyme functions in a physiological process often reveals early signs of disease that has a long latency period.

Matrix metalloproteinases (MMPs) are a family of matrix-degrading enzymes broadly expressed in normal and pathological processes. Structural proteins, such as collagens, are major targets of MMPs. For example, wound healing involves blood vessel epithelial cell reorganisation which requires the degradation of the original matrix and formation of a new matrix. Upregulation of MMP activities is also commonly observed in cancer metastasis where inter-cell adhesion proteins are decomposed to facilitate tumour cell migration. Measuring MMP activities provides information on cancer development. (1)

Synthetic peptide substrates are useful tools for MMP activity assays. A peptide substrate is designed to include consensus sequences that are recognised and cleaved by a specific MMP enzyme. The cleavage reaction rate is MMP activity-dependent and is determined via measuring the hydrolyzed product or unhydrolyzed substrate (or both). Though the concept is simple, there is one major limitation

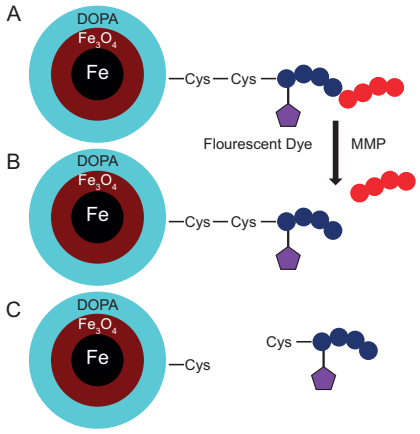


Fig 1. Fluorescently tagged magnetic nanoparticles for MMP-activity detection. A: DOPA-coated Fe/Fe3O4 nanoparticles with attached designer peptide sequence. B: MMP-catalyzed peptide cleavage. C: Reductive cleavage of the peptide (cleaved and uncleaved) from the magnetic nanoparticle.

caused by the way our body controls MMP activity: these enzymes are strongly regulated in the matrix. Therefore, MMP activities need to be, ideally, measured in the original sample matrix.

Here, we report a novel integrated microfluidic device that can automatically determine enzyme activities that uses peptide substrates attached to a nanoparticle platform and isoelectric focusing (IEF) separation of the substrates after reaction with the enzymes. Magnetic nanoparticles used in this device can be easily dispersed and retrieved from liquid samples, such as blood. (Fig 1.). Cleavable peptide substrates are bonded to magnetic nanoparticles via a disulfide bond which is breakable in a reducing environment. The peptide is labelled with a fluorescent dye for the convenient optical detection. Peptide substrates are cleaved when exposed to MMP enzymes, the reaction rate of which depends on sample MMP activities.

The workflow of the microfluidic device is illustrated (Fig 2.). Liquid samples such as blood or tissue fluids are collected for immediate analysis or storage at -20°C. Approximately 30 µL of sample is added to the sample reservoir where the sample and the synthesised magnetic nanoparticles are mixed (Fig2-1). With a Neodymium magnet underneath the microchip, the nanoparticles are vortex mixed with the sample. After 30 minutes incubation, a portion of the substrates

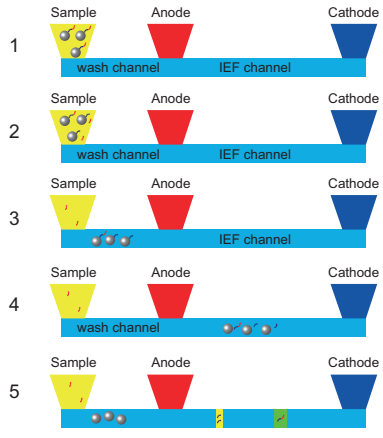


Fig 2. MMP activity measurement processes

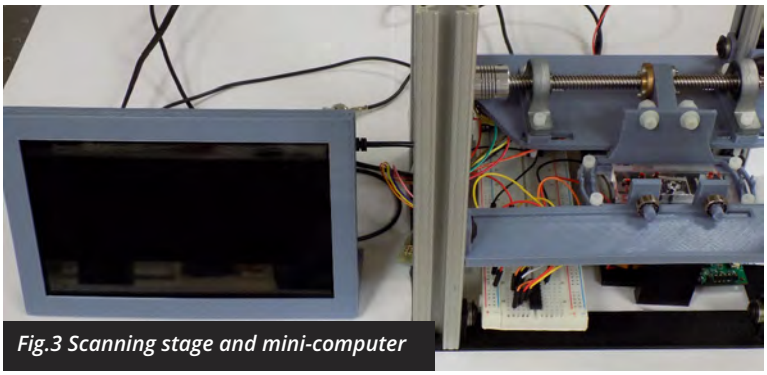
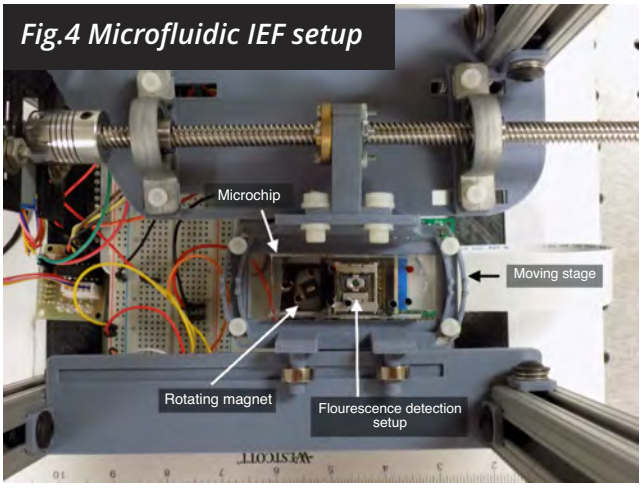


Fig.3 Scanning stage and mini-computer

Fig.4 Microfluidic IEF setup



on nanoparticles have been digested by the MMP enzyme (Fig 2-2). The undigested substrates and partially cleaved substrates both remain on the nanoparticles. All of the nanoparticles are transported from the sample reservoir into the wash channel (Fig 2-3). The wash channel contains physiological buffer that rinses off any MMP enzymes adsorbed on the nanoparticle surface to prevent further reaction and provides a clean sample for IEF. The nanoparticles are then transported into the IEF separation channel (Fig 2-4). The IEF separation channel contains reducing reagents that break the disulfide bonds connecting the substrates to the nanoparticle surface. After the detachment of substrates, magnetic nanoparticles are removed from the IEF separation channel. Digested and undigested substrates show different isoelectric points and are separated into two narrow zones in the separation channel (Fig 2-5). A laser-induced-fluorescence detector scans the IEF channel and collects the fluorescence readout from the two focused peptide substrates.

This microfluidic device has been integrated into a sample-in answer-out style workstation. (Fig 3.) The workstation consists of a minicomputer, a linear scanning moving stage, a stationary laser-induced fluorescence detector, a motorised magnet for on-chip nanoparticle manipulation and the microfluidic chip. (Fig 4.) An example of isoelectric point 4.5 peptide standard is shown. (Fig 5.) Under a pH gradient 3-10, the peptide standard is focused close to the low pH end (anode). This also demonstrates that peptides can be designed with an expected isoelectric point. This opens up possibilities to use multiple MMP substrates simultaneously with each substrate designed to be focused at different isoelectric points.

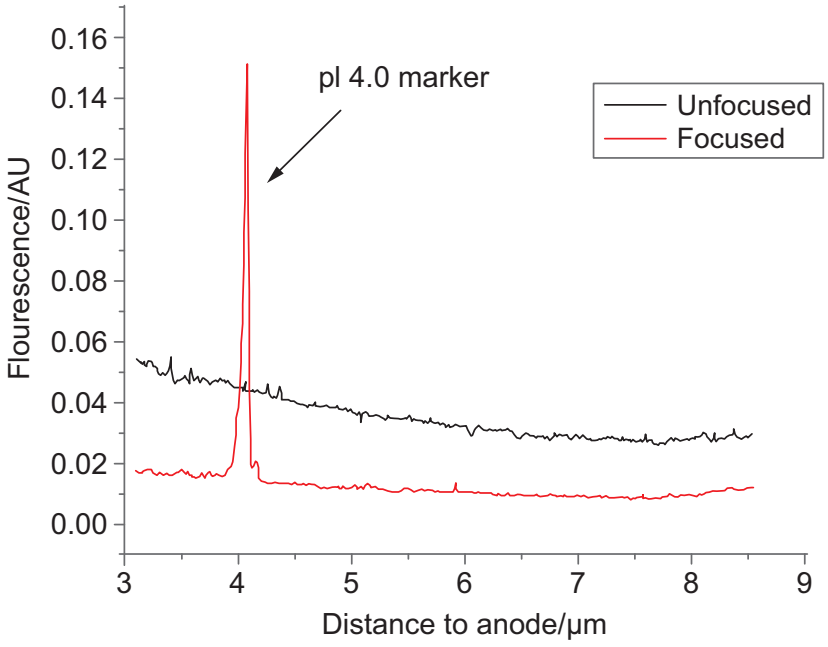


Fig 5. IEF of pI 4.5 marker GCEEH-(RhB)

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KANSAS STATE UNIVERSITY

Prof. Dr. Stefan H. Bossmann
University Distinguished Professor
Kansas State University
Tel: +1 785 532 6817
sbossman@ksu.edu
www.k-state.edu/chem/people/grad-faculty/bossmann/MicrofluidicWelcome.html
www.twitter.com/BossmannDr

Prof. Dr. Christopher T. Culbertson
Associate Dean for Research
College of Arts & Sciences
Tel: +1 785 532 6685
culbert@ksu.edu

A time of unprecedented opportunity for ecology and evolutionary biology

Stephanie E. Hampton, Division Director and George W. Gilchrist, Acting Deputy Division Director, at the National Science Foundation's Division of Environmental Biology, convey that now is a time of unprecedented opportunity for ecology and evolutionary biology

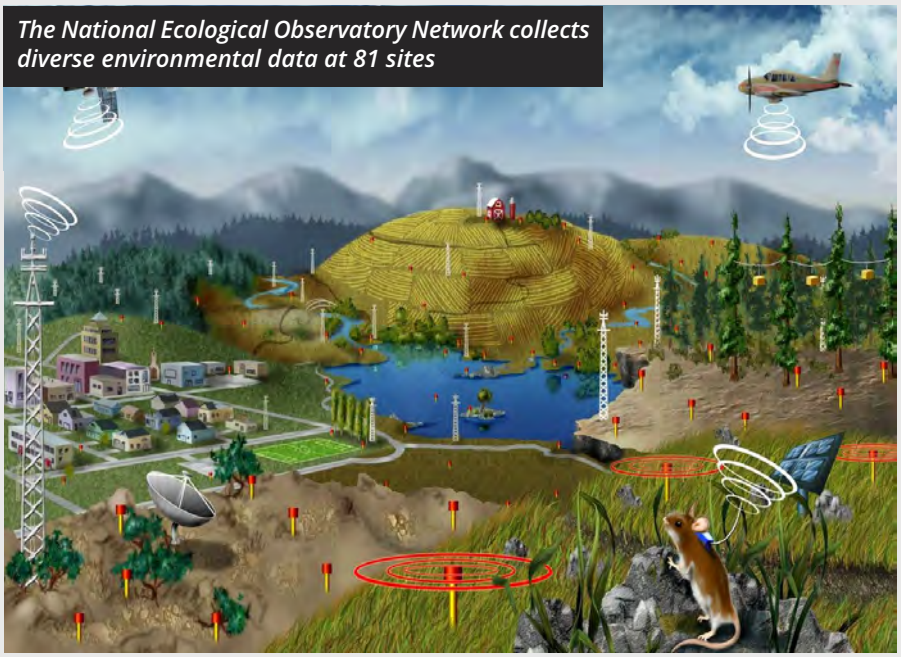
The disciplines of ecology and evolution have long been integrally associated. Ecology is the study of organisms' relationships with each other and their environments; evolution draws upon the understanding of these relationships to elucidate the processes by which organisms change over time and produce observed patterns in biodiversity. While the term ecology did not exist at the time that Charles Darwin took his voyage on The Beagle, his comparisons of the ways in which organisms interacted with each other and their environments (i.e. ecology) laid the foundations for understanding natural selection as a major force in evolution and patterns of biodiversity. In the decades since Darwin, technological advancement has transformed our understanding of ecological and evolutionary processes, allowing researchers to discern mechanisms underlying biological patterns from global to molecular scales. Over time, the fields of ecology and evolutionary biology have broadened and deepened, yet the fundamental nature of their interrelatedness continues to argue for them to progress side by side, as is evidenced by the many "Ecology and Evolution" programmes across universities worldwide.

Accordingly, at the National Science Foundation (NSF), the Biological Sciences Directorate (BIO) provides research funding for core ecology and evolutionary research through a single division, the Division of Environmental Biology (DEB). DEB supports research and training on evolutionary and ecological processes acting on organisms across multiple levels of organisation – from populations to ecosystems.

DEB core programmes are organised into four research clusters – Evolutionary Processes, Systematics and Biodiversity Sciences, Population and Community Ecology and Ecosystem Sciences. In these core programmes, innovative topics proposed by the research community comprise a diverse portfolio of research projects, fostering breakthroughs that can transform biology and disciplines beyond. For example, DEB has long supported epigenetics research, in which researchers examine the genome at the molecular level and seek to understand how it interacts with the environment to shape an observed organism's physical, behavioural and other biological traits. Epigenetics is now garnering increasing attention as we learn more about how the environment experienced by a parent can alter the genome and the traits of offspring, including humans. Epigenetics has been a high-profile topic for the Rules of Life theme within NSF's "10 Big Ideas," drawing vibrant interdisciplinary research to exciting questions at the core of DEB research.

Many of the transformative advances in evolution and biodiversity research have been propelled by the decreasing cost and increasing performance of genomic technologies; these approaches are now changing research throughout ecology as well. Genomic approaches not only add new dimensions to studies of familiar organisms, such as plants and animals, but also constitute the only feasible mode of comprehensively researching the ecology and evolution of microbes.

An explosion of research in all areas of biology focuses on the associations between microbes and larger, multicellular organisms. Most organisms, including humans, cannot survive without their microbial partners. DEB researchers are working to understand how microbiomes evolve and function in ecological and evolutionary processes. For example, bees are the most important pollinators of crops and other plants and are estimated to contribute at least $15 billion to U.S. crop production. Bees depend on their microbiomes to develop from larvae to adult, however, the normal microbial symbionts can be altered by pathogens,



The National Ecological Observatory Network collects diverse environmental data at 81 sites

Image: © Nicolle Rager Fuller, National Science Foundation

pesticides and invasive species. Researchers seek to characterise microbial diversity in flowers and pollen and then determine the nutritional role of those microbes in the development and health of larval bees. The goal is a comprehensive understanding of how bees and flowering plants interact via their shared microbial partners. Similarly, in virtually all plants, mycorrhizal fungi play a unique role in providing essential nutrients for growth. Research enabled by genomic sequencing is being used to probe this symbiosis. This project will determine how mycorrhizal symbioses affect the diversity, productivity and composition of plant communities. A better understanding of these interactions will help scientists and land managers sustain robust and resilient ecosystems.

Beyond these advances in core areas of ecology and evolutionary research, DEB partners with other NSF divisions and agencies to promote interdisciplinary research at the cutting edge of environmental biology. For example, DEB initiated the Dimensions of Biodiversity program in 2010 with a plan to revolutionise our understanding of the origins, maintenance and consequences of biodiversity. DEB has partnered with the NSF Geosciences Directorate, NASA and international funding agencies to expand the scope of these projects, which now number over 100. One important Dimensions project focuses on explanation and prediction of the distribution of animal and plant species in the megadiverse Brazilian Atlantic forest. This work combines cutting edge remote sensing, fossil pollen studies, molecular genetics, physiological assays and modern-day to paleoclimatic data to demonstrate how the biodiversity of the Atlantic forest evolved over time. The results identify specific factors that have generated much of the biodiversity of this region, providing new insights for resource managers and conservation scientists in this critically endangered habitat.

In recognition of both the need to address environmental questions at increasingly large scales and the tremendous potential of new technologies, BIO has taken the bold step of creating the National Ecological Observatory Network (NEON), managed by NSF's Division of Biological Infrastructure. NEON's network of instrumentation provides data to researchers in ecology, evolution and allied disciplines. NEON is designed to provide open access for scientists, educators, resource managers, policymakers and members of the general public interested in forecasting the impacts of climate change, land-use change and invasive species on ecological systems. In 81 terrestrial and aquatic sites across the nation, data are collected on select variables ranging from the biodiversity of native and invasive species to elemental chemistry and gas flux, genomics and disease occurrence. The NEON system is strategically designed to address environmental questions for which a coordinated network of standardised observations is particularly effective. In 2019, the construction was completed and the Observatory moved into full operations, poised to scale up our understanding of the Earth's systems to a degree never before possible. ■

Stephanie E. Hampton
Division Director
shampton@nsf.gov

George W. Gilchrist
Acting Deputy Division Director
ggilchri@nsf.gov

NSF Division of Environmental Biology (DEB)
National Science Foundation (NSF)
www.nsf.gov/div/index.jsp?div=DEB
www.twitter.com/NSF

Genetic testing: What's wrong with my child?

Dr Katie Finch discusses with Professors Darren Griffin and Alan Thornhill her personal journey involving genetic testing of her son Brandon

Whole genome sequencing has rapidly evolved from a multi-billion-dollar international research effort to a sub-£1,000 test available on the internet. But how has this been embraced and perceived by those who need it most? Do families with genetic conditions understand how far testing has come and are all clinicians involved in their care aware of how these developments could benefit their patients?

This article follows the personal journey of someone who, after completing a PhD studying chromosomes, discovered that her firstborn had a chromosome rearrangement.

For most families with a child displaying significant developmental delay, chromosome analysis (karyotyping) is the first test they encounter. First applied clinically in the 1970s, the report provides a picture resembling matching pairs of stripy socks. An extra sock number 21 would indicate Down syndrome for instance. Our chromosomes contain our genes, our genes make our proteins and proteins build every part of us. If a chromosome, or even part of one, is extra or missing, this presents a problem. Every family's case is unique. This is Katie and Brandon's.

Image: Nicola Dawson Photography

July 2012: *Brandon's parents were called to a meeting with the Lead Genetic Consultant to discuss results of the "DNA microarray" test taken three months earlier. Since birth, Brandon had gained a mere 1.8kg despite Total Parental Nutrition delivered directly to his bloodstream 24 hours a day; a perpetual struggle to get this five month old baby to just 10lb. He'd had tests for: Cystic Fibrosis (life-expectancy 40 years), ultrasounds for gall stones, Wolfran Syndrome tests (life-expectancy 30 years), Erythema Elevatum Diutinum (requiring a 5mm puncture wound through each layer of skin), ulcerative colitis (two endoscopies under general anaesthetic with multiple gastrointestinal biopsies), heart defects (ECG and ultrasound imaging), gastrointestinal motility disorder (multiple x-rays following a barium feed). Not to mention daily blood tests and four-hourly blood glucose heel-pricks.*

The geneticist explained that Brandon had a small deletion and a duplication on chromosome number 1 (arising while he was still an embryo). No other children had been recorded with this specific condition meaning no-one knew what this might entail for Brandon's future, or his life-expectancy.

Microarray results don't look like socks. They contain more precise information as to whether a piece of chromosome is extra or missing. From her PhD training, Katie knew exactly what Brandon's result "1q42.3q43x3, 1q43q44x1" meant in scientific terms; she was only just beginning to learn however that a clear diagnosis was the key to accessing essential support services, therapies and government benefits. Professionals like Katie can search databases to find similar reported cases, or trawl through hundreds of case-studies looking for links between patients; this is however more challenging for most families. Ultimately, even if two individuals have identical rearrangements, they may have vastly different symptoms and life prospects.

Rare chromosome conditions paradoxically are collectively common, affecting >400,000 children per year globally. Several professional and academic databases record these rare genomes but they can't always translate into useful information for families. The international organisation Unique (www.rarechromo.org) supports, informs and networks with families and professionals translating medical terminology and genetic results to families while sharing accessible stories. For many chromosome conditions, Unique has created comprehensive guides and can connect families with similar genomes for mutual advice and support. The specific guide for Brandon's condition highlighted an increased prevalence of flaws in midline brain development and associated seizures. Had Katie seen this guide in 2012, she would have been forewarned that her baby's eyes might roll into the back of his head, his body go limp and his lips turn blue as she held him. She could have learned how to deal with seizures before the first one happened.

It's important to remember that having a genetic result does not always translate to a specific diagnosis or named condition. The UK's SWAN organisation (**S**yndrome **W**ithout **A** **N**ame was established to support families where a child or young adult is believed to have a genetic condition but testing has failed to identify its cause. SWAN suggests that around 6,000 children with a genetic condition likely to remain undiagnosed are born every year in the UK alone. So, where do we go from here? What if an anomaly isn't detected in a child with a condition, or, even if it is, what if the genes affected don't match the symptoms?

The Deciphering Developmental Disorders (DDD) project began in 2011 and has decoded precise genetic sequences in genomes of >13,500 families within the UK's 24 Regional Genetics Services. Of the 6,000 children born with complex needs and no diagnosis, one-third will die before their fifth birthday. Questions have recently been raised regarding newborn screening since only nine diseases are screened for in the UK compared to 25-50 in most high-income countries. The rare disease community and Genetic Alliance have asked the UK Government to re-evaluate its newborn screening strategy.

The cost to the NHS of extending services, perhaps to whole genome sequencing, would undoubtedly be significant because, while sequencing costs continue to decrease, the cost to collate information and translate this appropriately to families is high in an already stretched service. Conversely, the potential for massive savings in neonatal and paediatric care is compelling by targeting diagnoses rather than simply testing for the most common disease first in an often fruitless, expensive and soul-destroying succession of tests – the so-called "diagnostic odyssey". In a society where whole genome screening can be ordered over the internet, it should be possible.

Finally, what does a genetic diagnosis mean for families affected by chromosome disorders? For some, it means that they can meet others in similar situations, learn from one another and be part of a wider community in a world that often excludes people who look or act differently. For Brandon, it means that his healthcare team can review other cases and pre-empt his future medical requirements; they can prepare other families that children with this particular rearrangement often have seizures and complex learning difficulties. Katie can seek support and provide it to others with similar rearrangements. Comprehensive genetic testing gives some families an answer they have previously sought in vain. It can give families the confidence to talk about their child's condition and answer that question that parents of children with additional needs regularly hear:

"What's wrong with your child?"
Rather than an awkward silence or embarrassed hunt for the right words, a parent can confidently reply:
"Nothing, but he does have a bit of chromosome 1 muddled up, which makes him a little different to other kids".

Darren K Griffin
Professor of Genetics
University of Kent, School of Biosciences
Tel: +44 (0)779 302 8711
d.k.griffin@kent.ac.uk
https://www.kent.ac.uk/biosciences/people/1244/griffin-darren
www.twitter.com/darrenkgriffin

Alan R Thornhill
Honorary Professor of Reproductive Genetics and Country Manager Igenomix UK
University of Kent, School of Biosciences and Igenomix UK Limited
Tel: +44 (0)7780 499 617
alan.thornhill@igenomix.com
https://www.igenomix.com

Katie A Finch
Rare Chromosome Condition Advocate and Principal Senior Embryologist
Bourn Hall Fertility Clinic
Katie.finch@bourn-hall.com
https://www.bournhall.co.uk/
www.twitter.com/drkatiefinch

A focus on biology: Peptide pathways to human evolution

Dr Sue Carter, Director, Emerita of The Kinsey Institute, argues that emotionally powerful social behaviours are built upon primal functions in her fascinating discussion concerning peptide pathways to human evolution

Human evolution and unique features of the human brain, can be traced to archaic chemical processes that began to appear over 600 million years ago. Amino-acid based molecules known as peptides, capable of reducing dehydration, allowed animals to move from aquatic environments to dry land. Particularly relevant to the evolution of modern mammals are two small peptides, oxytocin and vasopressin. Of these, vasopressin is more ancient. Oxytocin appeared much more recently and is central to the traits that define modern mammals.

Both oxytocin and vasopressin tune the central nervous system, setting the neurobiological stage for adaptive patterns of physiology and behaviour. Vasopressin is associated with anxiety and defensive behaviours, increases blood pressure and allows mobilisation in the face of danger. Oxytocin permits mammals to overcome the fear of others and use social relationships and cognition to cope with challenges and trauma.

These biochemical building blocks and their receptors are foundations for mammalian sexuality, birth, lactation and the capacity to adapt in an ever-changing environment. The same molecules that protect our bodies and allow reproduction, also facilitate our capacity to form social bonds and defend ourselves and those for whom we care.

Chemistry and bonding

Oxytocin and vasopressin are partners in a dynamic biochemical dance. Both consist of nine amino acids with 6 amino acid rings that are held together by disulfide bonds (Figure 1). Oxytocin influences the functions of vasopressin and vice versa, in part because these peptides are capable of binding to each other's receptors. Most of the oxytocin and vasopressin in the body is synthesised in the brain. However, receptors sensitive to these peptides are found throughout the body giving these molecules a central role in coordinating many physiological functions. Other hormones including gonadal and adrenal steroids also regulate both peptides and their receptors. When better understood, the interactions among these will likely help explain much of their biological versatility, ranging from the bonds formed between molecules to the selective relationships found in society.

Do oxytocin and vasopressin help to explain human nature?

Oxytocin played a central role in the evolution of the mammalian nervous system and may lie beneath the surface of several mysteries associated with human existence. Both the birth of a baby and releasing milk are facilitated by oxytocin's effects on muscles. In the postnatal period mothers (or comparable caretakers) provides milk and nurture to the dependent newborn. Falling in love with a baby also appears to be facilitated by oxytocin in both males and females. Bonding to an infant can occur in the absence of birth or lactation, providing several layers of physical and emotional support for the newborn. The human experiences of orgasm and, in males, ejaculation also are facilitated by oxytocin, possibly reinforcing adult social bonds.

Unique human traits including complex social cognition and language rely on the functions of the human cortex. The cortex requires a sophisticated autonomic nervous system and high levels of oxygen. The autonomic nervous system is dynamically regulated by both oxytocin and vasopressin, with abundant peptide receptors in the brainstem.

Vasopressin is a stress hormone, while oxytocin is of particular importance in "stress-coping," encouraging a sense of safety that allows positive social interactions even during periods of adversity and trauma. Across the lifespan, oxytocin may modulate emotional reactivity and increase social sensitivity.

During mammalian development, variations on these same molecules

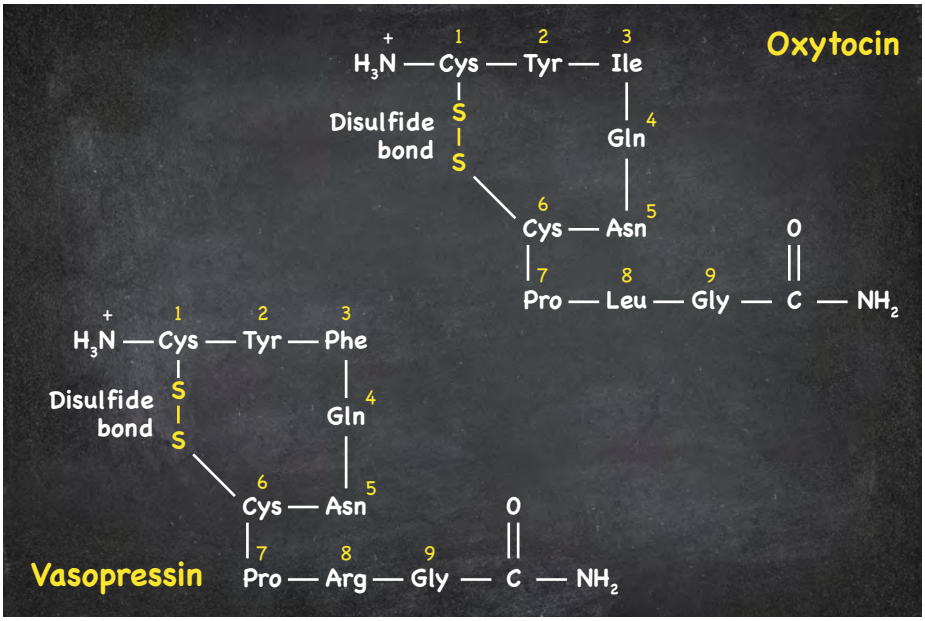


Figure 1: Oxytocin and vasopressin are peptide molecules consisting of 9 amino acids. Both have rings of 6 amino acid held together by sulfur-sulfur (disulfide) bonds. They differ from each other only by the amino acids at positions 3 and 8.

help physically sculpt the brain, heart and other tissues. Oxytocin can heal wounds and has therapeutic consequences throughout the body. For example, oxytocin appears to be a protective factor against cardiovascular disease, possibly by reducing inflammation and blood pressure, while vasopressin generally has opposite effects.

A mother's body is physically remodelled in part by oxytocin, eventually allowing birth. Oxytocin stimulates smooth muscles, such as those in the uterus, creating rhythmic contractions that are associated with sex and birth. Oxytocin is of special importance to humans, in which infants have comparatively large heads and communicative faces. Oxytocin plays a major role in the innervation of the face and facilitates social communication. Oxytocin physically and functionally shapes the neocortex, allowing a nervous system capable of language and social cognition. Oxytocin also is analgesic and protects both mother and infant from pain and the memory of pain associated with childbirth. Oxytocin functions in conjunction with other molecules, including dopamine and opioids, to transform experiences from pain to pleasure and to reduce the consequences of traumatic stress.

Although characterised initially as a "female reproductive hormone," it is now clear that oxytocin acts in both sexes. In contrast, vasopressin, especially in brain regions associated with defence, is regulated by androgens and of particular importance in males. Both sexes use changes in the vasopressin system to adapt to threatening experiences, but there is increasing evidence that males are more sensitive to vasopressin than females. Males may show a more mobilised response to danger, while females tend to respond to apparently similar stressors with immobilisation or anxiety. Depression and a tendency to emotionally shutting-down after a traumatic experience are two to four times more likely in females than males. Vasopressin can support active defensive behaviours and lowers thresholds to aggression. It is also possible that sex differences in aggression and reactions to infants are at least partially due to sex differences in sensitivity to vasopressin and oxytocin.

Pathways to peace

In a world torn by fear and violence, it is easy to forget that humans are the primates that rely most strongly for their survival on social relationships. Knowledge of the roots of both peace and war are critical to our future as a species. The deeply-buried secrets at the core of human evolution are only now being uncovered.

Understanding the actions of peptides and especially oxytocin is offering new perspectives into the physiological and evolutionary origins of what it means to be human. This knowledge also suggests pathways through which we may optimise human health and wellbeing.

Suggested reading

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Kinsey Institute
INDIANA UNIVERSITY

Dr. C. Sue Carter
Director, Emerita and Distinquished University Research Scientist
suecarter@indiana.edu
https://kinseyinstitute.org/about/profiles/cscarter.php

Vitamin D boosts maternal and child health

Dr Andrew Bremer, a Paediatric Endocrinologist and Chief of the Pediatric Growth and Nutrition Branch at the Eunice Kennedy Shriver National Institute of Child Health and Human Development (NICHD), part of the U.S. National Institutes of Health, details NICHD-supported research on vitamin D in pregnancy and early childhood development

Vitamin D , a hormone found in some foods and produced by the body after exposure to the sun, is important to our health in many ways: it helps the body build and maintain strong bones, plays a role in reducing oxidative stress and inflammation and helps our nervous system develop and carry messages from the brain to cells throughout the body. Vitamin D also helps the immune system fight off invading bacteria and viruses.

Vitamin D in Pregnancy

Vitamin D deficiency during pregnancy has been linked to adverse pregnancy outcomes and may predispose women to gestational diabetes and preeclampsia. However, according to a recent NICHD study, sufficient levels of vitamin D before conception may play a protective role in pregnancy. Insufficient vitamin D levels were linked to miscarriage among women with a prior pregnancy loss. Researchers analysed data from about 1,200 women during preconception, attempting pregnancy and throughout the pregnancy. The study tracked time to pregnancy, pregnancy loss and live births. About half of the women enrolled in the study had sufficient vitamin D levels, while a little more than half had insufficient concentrations. Among women planning to conceive after a pregnancy loss,

Dr Andrew Bremer, Paediatric Endocrinologist

those who had sufficient levels of vitamin D were more likely to become pregnant and have a live birth, according to the analysis.

Another study linked vitamin D levels during pregnancy to birth weight and bone size of infants. Researchers found that among women who were overweight or obese before pregnancy, low vitamin D concentrations in both early and late pregnancy impacted fetal development. Considering that almost half of U.S. women entering pregnancy are overweight or obese, the authors wrote, prevention of low vitamin D concentrations in early and late pregnancy may optimise fetal growth.

Vitamin D in childhood

Scientists continue to discover new ways vitamin D supports health. A recent study found that infants or young children with low levels of vitamin D may have a risk of high blood pressure later in childhood or adolescence. Researchers analysed data from 775 children enrolled at birth in a long-term study of obesity risk factors. The children were followed until the age of 18.

Researchers measured vitamin D levels from blood samples taken at birth and in early childhood. The children's systolic blood pressure (the top number in a blood pressure reading) was taken annually from ages three through 18.

Children with a low vitamin D level at birth had a 38% higher risk for elevated systolic blood pressure at ages six through 18, compared to children with a sufficient vitamin D level at birth. Children with a low vitamin D level at ages 1 to 3 had a nearly 60% higher risk of elevated systolic pressure from ages 3 to 18. If the study results are confirmed, treating pregnant women and young children for vitamin D deficiency may help reduce the risk of high blood pressure later in life.

Given the many functions of vitamin D and the association of vitamin D deficiency with hypertension, diabetes mellitus, metabolic syndrome, cancer, autoimmune and infectious diseases, among other health complications, ensuring Vitamin D sufficiency in the population is a public health priority. Moreover, the association between maternal vitamin D status and health outcomes for the mother and her offspring highlight the potential ill-effects of vitamin D insufficiency through the generations. ■

Dr Andrew Bremer
Paediatric Endocrinologist
Chief of the Pediatric Growth and Nutrition Branch
Eunice Kennedy Shriver National Institute of Child Health and Human Development (NICHD)
U.S. National Institutes of Health
Tel: +1 800 370 2943
NICHDInformationResourceCenter@mail.nih.gov
www.nichd.nih.gov/
www.twitter.com/nichd_nih

Synthetic biology: Past, present and future

Gábor Balázsi, Ph.D. from the Louis and Beatrice Laufer Center for Physical and Quantitative Biology and the Department of Biomedical Engineering at Stony Brook University in the U.S., shares his perspective on the field of synthetic biology in terms of the past, present and future

"What I cannot create, I do not understand" – wrote Richard Feynman on his blackboard decades ago. We all know from experience that struggling to create something such as a working radio, a meal or even the cheque book balance can reveal strengths and weaknesses in our understanding. Almost all the machines and tools we use, from corkscrews to cell phones to rockets highlight our understanding of non-living, physical and chemical systems. On the other hand, despite millennia of observing the living world, human-built living devices do not exist – or at least not until recently. That is about to change now, as a new generation of scientists started engineering biology, establishing the new field of synthetic biology. Synthetic biologists aim to create artificial biological systems for specific purposes by modifying and assembling the molecular components of living cells in new ways.

It all started with two scientific papers in 2000 *Nature 403(6767):335-42 (2000)* reporting on switches and oscillators constructed from genes. These new "gene circuits" did not just emerge from trial and error: their capabilities were mathematically predictable. In other words, the gene circuits had designable behaviours, just like engineers design new machines on paper or within a computer beforehand. Many other gene circuits followed, including pulse detectors, light sensors, counters, memory devices, dimmers and logic gates *Nature Reviews Microbiology 12, 381–390 (2014)*. As the complexity and number of such biological devices increased, discussions and hopes about their potential uses intensified, including medical and industrial applications. The hope for practical applications stimulated the emergence of a second branch of synthetic biology, focused on metabolic engineering and bioproduct fabrication, starting with the successful synthesis of an otherwise expensive anti-malarial drug precursor, by moving appropriate plant genes into bacteria and then yeast in 2003 and 2006 *Nature 440(7086):940-3 (2006)*. A third branch emerged as well, aimed to synthesise and edit entire genomes. Whole-genome engineering started with viruses, then continued with bacteria and yeast *Science 351 (6280):aad6253 (2016); Science 355(6329): 1040-4 (2017)*, reflecting the increasing ease of DNA synthesis. From these achievements, it is conceivable that fully synthetic human genomes will eventually follow, although it is unclear when.

The three branches of synthetic biology have somewhat different goals, methods and promises. Closest to mindful engineering is perhaps novel gene circuit development, which relies most on mathematics for design and performance prediction. The other two branches (metabolic and whole-genome engineering) are closer to automation and tend to rely on biotechnology more than mathematics. In Feynman's terms, gene circuit development exemplifies human creation of novel bio-devices, whereas the other two branches are closer to recreating, copying nature's own, existing designs. Practical benefits from gene circuit development may be less straightforward and farther-away than the benefits from the other two branches, which are already enabling the cost-effective synthesis of pharmaceuticals, biofuels and cosmetics and are attracting the attention of industry and start-ups. Nonetheless, we will focus here on synthetic gene circuits, to increase public understanding of how they work and appreciation of why they may be important.

Gene circuit development relies on the ability to cut, copy and paste DNA, the stringy hereditary material of every living cell containing a code written in four letters: A, C, T, G. Each gene is a piece of DNA, carrying the code the cell uses to produce one of its thousands of proteins. The types and amounts of proteins present in a cell determine what the cell does – whether it sits in specific tissues or moves away, whether it resists external stresses, or whether it produces certain biochemical compounds. Adding, deleting or editing a gene adds, removes or alters the corresponding protein, respectively.

However, modifying certain genes can have indirect effects: besides the protein they encode, the levels of some other proteins will change. Typically, these indirectly-acting genes encode transcription factor proteins that bind to promoter regions near other genes

to either promote (activate) or slow (repress) their protein synthesis. Pairing such genes and the corresponding promoters in new, artificial configurations enables connecting them in predesigned ways, creating gene circuits. For example, pairing a gene with a promoter it represses gives rise to a simple negative feedback gene circuit that can be used to precisely control cellular protein levels *Proc. Natl. Acad. Sci. USA. 106(13):5123-8 (2009)*. Pairing a gene with a promoter repressed by another gene and vice versa results in a genetic toggle switch *Nature 403 (6767):335-42 (2000)*. To become functional, the DNA sequence of gene circuits must be introduced into living cells that can make the proteins corresponding to each gene.

Biotechnology is increasingly capable of manipulating DNA strings. Currently, the most exciting advances in biotechnology involve precisely cutting, editing, writing and reassembling DNA sequences. Longer and longer synthetic DNA pieces can be ordered for falling prices, meaning that gene circuit engineering is simpler and more accessible by the day. However, the ability to reliably predict the capabilities and robustness of newly assembled synthetic gene circuits has not kept pace. Unlike in electronics where circuit components are typically standardised, with known tolerances and error rates, little of that holds for genetic components. Part of the problem is biological knowledge gaps – we still do not know exactly the function of each stretch of DNA sequence. Moreover, even known DNA functions can change depending on the host cell's genome or the environment.

Efforts have been underway to simplify gene circuit sequences, minimise host genomes and standardise genetic parts to eliminate some of that uncertainty, making gene circuit behaviour predictable by engineering software. However the exact details we aim to predict matter – it is unlikely that we can predict the levels of every protein in every single cell, despite their importance. Second, even if gene circuit function is predictable in some precisely-defined cell type and environment, the predictions may fall apart as soon as one of these factors (such as cell type) changes. Third, the behaviour of the initially intact gene circuit may change as mutations randomly arise, as they inevitably do in nature. Overall, major challenges await to be addressed before synthetic biology can deliver on some of its promises.

Once some of these difficulties are resolved, future opportunities for synthetic gene circuits are abundant, almost infinite – considering the immense number of cell types and possible applications. Gene circuits can sense and report on almost anything that happens inside living cells or can act as control knobs that allow humans to interact with cells and drive cell behaviours. Knowing what cells do and manipulating their behaviour could revolutionise cell, tissue and organ transplantation and engineering, stem cell- and immunotherapies, as well as gene therapies. It could also aid environmental remediation, biomaterial synthesis and biofuel production and it can contribute to cosmic travel and defence applications.

Supporting basic synthetic gene circuit research is crucial to enable the future advances we desire. Currently, gene circuit development is the branch of synthetic biology that could lead to the broadest range of applications from medicine to ecology to agriculture. Yet, the interest of the private sector in gene circuits is modest because the deliverables are less immediate than for metabolic engineering and bioproduct synthesis. While some nationwide funding initiatives for basic synthetic biology research exist, such as the UK's Biotechnology and Biological Sciences Research Council (BBSRC) prioritising the field, the U.S. Office of Naval Research or the NSF-funded multi-university consortium Synberc, they are insufficient and do not distinguish between the three branches of synthetic biology. Since the area is still young, it is difficult to recruit reviewers for synthetic biology proposals. Synthetic biology proposals submitted to national funding agencies are typically reviewed by panels of traditional biologists, along with traditional biology grants, leading to low success rates. This situation is unlikely to change unless definite, unorthodox steps are taken to support this highly promising field, especially the design and basic, quantitative characterisation of synthetic gene circuits, which has attracted less industrial interest and support than the other branches of synthetic biology.

Overall, synthetic gene circuits could be exactly the tools we will need to address many societal challenges we will be increasingly facing – including ageing, cancer, drug-resistant microbes, environmental pollution – but whether we will have these tools when such challenges truly arise depends on what we do right now.

LAUFER CENTER
FOR PHYSICAL AND QUANTITATIVE BIOLOGY

Stony Brook University

Gábor Balázsi, Ph.D.
Henry Laufer Associate Professor
Stony Brook University
Tel: +1-631-632-5414
gabor.balazsi@stonybrook.edu
http://laufercenter.stonybrook.edu/people/faculty

The role of vitamin D in pregnancy

Dr Larisa Corda Obstetrician and Gynaecologist shares her expert thoughts here on the role of vitamin D in pregnancy

Vitamin D is a steroid vitamin from a group of fat-soluble prohormones. There is no doubt that it's important in pregnancy and expecting mothers need to make sure they get the recommended amounts of vitamin D during pregnancy for both their own well-being and the healthy development of their baby.

Research has demonstrated it to be safe and effective for both mother and baby and as most of us are vitamin D deficient, daily dosages are recommended. The average prenatal supplement contains 400 units of this, but it is recommended that women who are at particularly high risk should take at least 100 units per day. Women who are more at risk of pre-eclampsia, such as those who are older, obese, have hypertension or have suffered from previous pre-eclampsia, those carrying twins, those with a history of diabetes, or those who conceived via IVF (in particular with donor eggs) should take a recommended dose of 800 units per day as per the Royal College of Obstetricians and Gynaecologists (RCOG).

Vitamin D is beneficial for both the mother's and baby's wellbeing. The most well-recognised benefit is improving bone health. However, it also has an increasingly recognised repertoire of nonclassical actions, such as promoting insulin action and secretion, immune modulation and lung development. It, therefore, has the potential to influence many factors in the developing foetus. Many studies are finding a connection between low serum vitamin D levels and an increased risk of certain types of cancers, autoimmune disease, neurological disease, insulin resistance and cardiovascular disease.

More specifically in pregnancy, Vitamin D supplementation has been shown to reduce the risk of pre-eclampsia and low birth weight. Low vitamin D levels in late pregnancy were associated with reduced intrauterine long bone growth and lower gestational age at delivery.

Adequate levels of Vitamin D in pregnancy were also found to reduce the risk of gestational diabetes, caesarean section and bacterial vaginosis, as well as potentially postpartum haemorrhage. It may also protect against low calcium in the neonate and seizures due to this, especially in women who are South Asian.

> "Vitamin D containing foods can help to improve vitamin levels in someone who is deficient. Research also suggests sensible sun exposure (usually 5-10 minutes of exposure of the arms and legs or the hands, arms and face, two or three times per week) can help as well."

At this time, 40-60% of the entire UK population is vitamin D deficient, including pregnant women. Those most at risk are those with pigmented skin, those who are overweight and being pregnant during the Winter and Spring months. Pre-pregnancy obesity has been associated with lower levels of vitamin D in both pregnant women and their neonates; 61% of women who were obese (body mass index [BMI] ≥ 30) prior to pregnancy were found to be vitamin D deficient, compared to 36% of women with a pre-pregnancy BMI of less than 25.

Vitamin D is found in egg yolk, salmon and cod liver oil; however, most vitamin D is consumed through fortified foods like milk. For 75% of the population that is lactose intolerant, fortified milk products are not a reliable source of vitamin D consumption.

Age, how much time you spend outdoors, pollution and having a healthy gut are all factors that affect the amount of vitamin D in our bodies.

Vitamin D containing foods can help to improve vitamin levels in someone who is deficient. Research also suggests sensible sun exposure (usually 5-10 minutes of exposure of the arms and legs or the hands, arms and face, two or three times per week) can help as well.

"Vitamin D is beneficial for both the mother's and baby's wellbeing. The most well-recognised benefit is improving bone health. However, it also has an increasingly recognised repertoire of nonclassical actions, such as promoting insulin action and secretion, immune modulation and lung development."

However, the best way to really ensure adequate vitamin D is through simple supplementation. When supplementing, your choices will be between two forms of vitamin D. Ergocalciferol is the vegetarian form of vitamin D and cholecalciferol is the animal-sourced form, usually derived from fish liver oil or lanolin from sheep.

There are no data to support routine screening for vitamin D deficiency in pregnancy in terms of health benefits or cost- effectiveness. There is an argument that some groups of women who are pregnant should have a screening test: for example, on the basis of skin colour or coverage, obesity, risk of pre-eclampsia, or gastroenterological conditions limiting fat absorption. Generally speaking, as Vitamin D is safe, universally offering it to all pregnant women has been approved by the RCOG. ■

Dr Larisa Corda
Obstetrician and Gynaecologist
www.drlarisacorda.com
www.twitter.com/DrLarisaTV
www.instagram.com/DrLarisaCorda

Environmental exposures during early life influence adult disease risk

Carolyn R. Klocke and Pamela J. Lein discuss how an individual's experiences during early life can influence their risk for disease as an adult

An individual's experiences during early life can influence their risk for disease as an adult. Dr. David Barker first postulated this in the 1980s following his observations that infants born with low birth weight were at significantly increased risk for developing cardiovascular disease as adults. This idea was controversial at the time because it challenged the conventional thinking that unhealthy lifestyle was the primary cause of cardiovascular disease. However, subsequent epidemiologic studies confirmed Barker's findings and the concept that early-life experiences are an important determinant of adult disease risk became known as the "Barker hypothesis".

While the Barker hypothesis was derived from evidence linking foetal malnutrition to cardiovascular disease risk in adulthood, the concept has since expanded to include a broader spectrum of risk factors, diverse disease states targeting different organ systems, and developmental periods extending beyond gestation. In recognition of this paradigm shift, the Barker hypothesis was renamed the developmental origins of health and disease (DOHaD) hypothesis. Several decades of DOHaD research have identified at least four categories of early-life risk factors: the nutritional status of the pregnant woman and young child, psychosocial stress, immunological stress, particularly infection during pregnancy, and chemical exposures. It is now also appreciated that the risk of most, if not all, adult-onset diseases are influenced by early-life stress, but only if exposures occur during specific periods of development. These high-risk periods are referred to as "critical periods" or "critical windows of development", and these vary depending on the early-life insult and the target organ. For many organ systems, however, the foetal period is the primary critical window.

The nervous system is particularly vulnerable to early-life stressors, perhaps because human brain development continues after birth, throughout early childhood and into adolescence. To date, research supports an association between early-life environmental insults and increased risk of neuropsychiatric disorders like schizophrenia, demyelinating diseases, such as multiple sclerosis (MS), and neurodegenerative diseases, such as Alzheimer's and Parkinson's diseases (AD and PD, respectively). Whether an early-life stressor increases an individual's risk for neuropsychiatric or neurologic disease depends on numerous factors. What is the type and magnitude of the stressor? Is the insult continuous, intermittent, or a single isolated incident? What is the timing of exposure relative to critical windows of development, which vary across different brain regions? Does the affected individual carry genes that confer increased susceptibility or increased resistance to the adverse effects of the stressor? Sex also influences the

impacts of early-life stressors, perhaps because gonadal sex hormones influence many of the organisational aspects of neurodevelopment. Examining the sex-specificity of early-life stressors may be important for understanding why many neurological and neuropsychiatric diseases exhibit a sex bias in their incidence and clinical profile.

Maternal infection during pregnancy is strongly linked to increased risk of schizophrenia, though it does not appear that any specific pathogen or class of pathogens is responsible. While there is disagreement as to whether a specific trimester of pregnancy is most vulnerable, the pro-inflammatory environment created by maternal infection is thought to alter the pattern of cellular connections made in the foetal brain, laying the groundwork for altered behavior in adulthood. Emerging evidence also suggests that early-life exposure to the lead (Pb) may increase risk for schizophrenia, particularly in individuals that express a mutation in the disrupted in schizophrenia 1 (DISC-1) gene, a gene that is strongly associated with schizophrenia and related mental disorders. AD is the most common cause of progressive dementia in elderly adults and it is rapidly increasing in global incidence; PD is the second most common neurodegenerative disease after AD. Only a small percentage of cases of either disease can be attributed to solely genetic causes, supporting a role for environmental factors in determining individual risk. Recent studies have identified early-life risk factors for AD and PD, including low birth weight, premature birth, living in a rural area, low socioeconomic status during childhood, and prenatal or early childhood exposures to environmental pollutants, including heavy metals, pesticides, and air pollution. Air pollution has also been linked to an increased risk of MS.

A key question in the field is how do early-life events influence risk of adult-onset disease? It is believed that environmental stressors disrupt the organisational patterning and/or function of the developing brain by altering cell numbers or interfering with the differentiation of neurons or glial cells. So why do these changes not manifest as functional deficits or disease until adulthood? One explanation is that the affected cells are not functional until later in life. For example, exposure of the developing brain to high concentrations of the food additive monosodium glutamate (MSG) causes excessive death of neurons in the hypothalamus by triggering apoptosis, a form of programmed cell death. However, functional deficits associated with the foetal loss of these hypothalamic neurons (hypogonadism and infertility) become evident only in adolescence when the neuroendocrine function of these neurons is normally activated. Alternatively, the adverse impacts of the early-life stressor are masked or initially attenuated due to compensatory mechanisms or plasticity of the brain. However, these developmental perturbations predispose the individual to neural deficits following subsequent insults, such as chemical exposure, disease, or aging due to decreased brain reserve capacity. This phenomenon has been demonstrated in both animal models and humans following developmental exposures to methyl mercury or pesticides.

In summary, the experimental evidence indicates that early-life insults can fundamentally change the trajectory of brain development, thereby diminishing the ability of the brain to protect against subsequent insults, which increases susceptibility to disease in adulthood. A significant challenge in the field is to identify early-life stressors that increase adult-onset disease in humans. Detecting effects in the human population is difficult because the effects do not manifest until well after the developmental exposure. However, the effort to identify these associations merits investment of research dollars because preventing disease by identifying and reducing or eliminating risk factors is more effective than treating disease in terms of both individual and societal costs.

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Carolyn R. Klocke, PhD
Postdoctoral Scholar
University of California, Davis
crklocke@ucdavis.edu
www.linkedin.com/in/carolyn-klocke

Pamela J. Lein, PhD
Professor
University of California, Davis
Tel: 1-530-752-1970
pjlein@ucdavis.edu
http://www.vetmed.ucdavis.edu/lein-lab/
www.twitter.com/UCDATEHS1

The role of parents' in helping children to develop language

Bob Reitemeier, Chief Executive of I CAN, focuses on the crucial role of parents' in helping children to develop language

Over the summer holidays, the demographics of the train on my journey into work changes. There are many more families out on day trips – so instead of newspapers, laptops and relative silence, there are comics, tablets and the wonderful sound of children's voices. Working in the field of children's communication development, I know that parents' role in helping children to develop language is key, so I'm always interested to see how much parents talk with their children.

Given the amount of time children spend at home compared to a nursery or at school, it's probably not surprising that parents are so important in their children's language development. But studies have shown that the way in which parents speak with their children can predict how proficient they become as a communicator. It also impacts on how well they do at school. One large-scale project which followed up children from pre-school into school found that what parents and carers do makes a real difference to children's development; activities such as reading to children, teaching songs, taking them on visits and creating regular opportunities to play with friends at home were linked to improved learning.

On my journey into work during August, I see this first-hand. Where families are in open conversation with their children, pointing things out, asking and answering questions their children are fully engaged and often exploring new words. It is a pleasure to sit and observe.

Many of you reading this may be thinking – that's obvious, isn't it? Well, you'd think so, but it often isn't the case. In 2018, I CAN the children's communication charity, with the Royal College of Speech and Language Therapists produced a report, Bercow: Ten Years On. This reported on the findings of a review of provision for children and young people with speech, language and communication needs (SLCN). One of the key findings was a lack of public awareness of the importance of children's communication and language. In a survey carried out as part of the review, 77% of parents who were worried about their child's speech and language difficulties felt that the information they needed was either not available or difficult to find and in a further survey, nearly half of parents did not know what to expect their child to be saying at age two.

It's now a well-known fact that many children don't develop the language skills they need to start school. In a survey of school leaders about school readiness, children's poor speech and language was the biggest concern with 97% of respondents identifying this as a problem and 47% saying it was the most significant. In fact, robust studies show that in some areas of the UK around 50% of children start school with delayed language. That's a significant number: half the children in some classrooms finding it hard to sit and listen, with only a handful of words, unable to string a sentence together.

There is now more and more known about how important children's language is at age five. It's the single most important factor in their reading at age 11 and can predict exam results at school leaving age. Children need good language skills to learn, so having poor language puts children on the backfoot right from the start.

But there is some good news.

The fact that parents play an important role in young children's language development has not gone unnoticed. In the summer of 2018, Damian Hinds – then the

Bob Reitemeier, Chief Executive of I CAN

Secretary of State for Education, announced that the number of children starting school with poor communication was unacceptable. He made it his ambition to half that number over the next ten years and the Department for Education launched a campaign to help change the home learning environment, with an accompanying website for parents, called Hungry Little Minds.

> "Given the amount of time children spend at home compared to a nursery or at school, it's probably not surprising that parents are so important in their children's language development."

National campaigns such as the National Literacy Trust's Small Talk, the BBC's Tiny Happy People or Hungry Little Minds are providing much-needed information to parents and carers. Locally, there are many examples of excellent information and resources, for example in Nottinghamshire, Warwickshire, Stoke or Worcestershire.

Often different parents want information in different formats so at I CAN, we are exploring a range of ways to support parents in communities across England. We are leading a Department for Education funded project called Change the Conversation about Language which combines workshops with parents, a network of parent champions and an accessible App so that families have a choice of how they get the information they need and want. Our Talking Point website is a one-stop shop of really practical information with an online tool for parents to monitor the progression of their child's early talking, listening and understanding. For parents wanting to speak with someone more directly, our free enquiry line provides the opportunity to speak with an experienced speech and language therapist.

It is often said that being a parent is the toughest job in the world. For first-time parents, one of the reasons it is so tough, especially in the very early days, is the enormous sense of responsibility that comes with the birth of a child. It can also be the best job in the world and one way to make it so, is by helping parents understand how they can positively influence their child's development. Encouraging language, starting as early as when the child is in the womb, is one very important element of human development, so let's work together to spread the word – literally! ■

Bob Reitemeier
Chief Executive
I CAN
Tel: +44 (0)20 7843 2510
info@ican.org.uk
www.ican.org.uk
www.twitter.com/ICANcharity

Detecting Specific Language Impairment (SLI) in children

Mabel L Rice analyses the cause of Specific Language Impairment (SLI) and the need to identify it early on in children to provide a solution

Children around the world acquire their native language, or languages, without the need for explicit formal teaching. Yet children vary in how well they manage this task in comparison to their age mates. Children's language continues to grow during childhood as they acquire sentence structures, grammatical elements to mark case, person, tense, agreement of subject and verb, vocabulary, and a host of other details. Some children are behind at the beginning but catch up to their peers by four or five years of age; other children continue to trail behind their peers into adulthood, leaving them with less robust language abilities for negotiating life's educational demands, interactions with unfamiliar people, and employment positions. Most of this group of children have a language disorder that delays the mastery of language in children who have no hearing loss or other developmental delays, known as Specific Language Impairment (SLI) [1,2].

SLI is likely to be undetected by parents and teachers, given the lack of an obvious cause of the condition. This means that a primary need is for how to identify children with SLI. Once identified, children should receive help to overcome their limitations in learning a language. Robust language skills for every child are robust assets for the individuals to contribute to their families and their societies to the benefit of others and themselves.

Around the world, solutions to these needs and increased likelihood of a good life for all children depend on a careful scientific study across languages of the children's pathways into their native languages. Detection of how one child is different from others of his or her own age requires an understanding of how children master different language skills at different ages. In turn, this knowledge requires a good understanding of the details of each language and similarities across languages. Much of the available research is based on English-speaking children, although there are rapid advances underway in documenting how children acquire many of the world's major languages.

The ultimate objective is to provide guidance for the development of effective teaching practices to assist children who do not acquire language as easily as their age peers, in order to prepare them for a productive life as an adult. Although this may seem to be obvious, perhaps just a matter of insisting a child talk better or for adults to talk more to a child. Neither of these approaches are likely to be effective. It would be like insisting that a child be taller or have different hair colour. Instead, effective teaching approaches require a consideration of four factors that vary considerably from country to country around the world.

> "Some children are more at risk than others. During the toddler age range, boys are later to acquire language than are girls, a gap that can persist to five or six years of age."

Governmental/societal policies

There is considerable variation across developed countries in the organisation of governmental resources and oversight for services for children with SLI. In the United States (U.S.), the public schools are required to provide speech/language pathology services for children with language impairments, in the context of an individualised education plan (IEP) developed in teams of classroom teachers and other educational specialists. Speech/language pathologists are required to be certified at the level of a master's degree. States vary widely in the exact definitions of eligibility for services. Some states would exclude children with SLI whereas others would include them and encourage them to be enrolled in services. Schools are not the exclusive setting for services in the U.S. Private practitioners, usually but not exclusively speech/language pathologists, also enrol children with SLI in treatment, which is usually but not always paid by private health insurance plans. Less

likely are services provided through military benefits or in association with a medical practice, such as a paediatrician who specialises in SLI.

In contrast, in many countries services are implemented under a public health system, sometimes in arrangements with schools and sometimes in private practices with a government-sponsored insurance program. Around the world, there are various configurations of these country-wide policies. The availability of speech/language pathologists with specialised training, and the level of training required, also varies greatly.

Teaching settings

The settings in which language teaching can occur also vary widely. Across the world, the most prevalent setting is a home, although home-based professional services are expensive and unlikely. Instead, the school classroom is the likely setting, as part of the teacher's approach to teaching each child in the age-defined classroom. Obviously, this has limitations related to the size of the classroom and the teacher's training. In the developed nations there is widespread recognition of the impact of preschool settings designed to enhance children's language abilities, as a strong platform for later education including the transition to reading. Private practice services are more likely to be with an individual teacher than in a group setting.

Specialised training

Teacher training, as well as paediatric training, involves a wide range of content areas and usually does not include specialised information about linguistic structures and sociolinguistic skills that are essential to the identification of children with SLI or teaching methods. Speech/language pathologists in the U.S. are likely to receive this training although training approaches vary widely. There is a great need for the specialised training that will benefit all children.

Child characteristics

Some children are more at risk than others. During the toddler age range, boys are later to acquire language than are girls, a gap that can persist to five or six years of age. Little is known about how gender differences play out over childhood. A recent well documented but surprising finding is that adolescent girls score lower than boys on vocabulary understanding, with the lowest performance by adolescent girls with SLI [3]. Some risk factors have been widely assumed, such as low levels of maternal education or low levels of a child's nonverbal intelligence, although the evidence for these generalisations is not straightforward, suggesting that the generalisations do not always hold. [1,2]

How to teach

Teaching should be culturally sensitive and effective for enhancing each child's language development across multiple dimensions of language, including grammar, vocabulary, and social uses of language. Note that the big challenge is how to teach language to a child with SLI in a way that causes them to learn language faster than their age peers in order to catch up. The catch-up period may extend over the years, requiring sustained treatments, and the age of first intervention will matter.

These are formidable challenges and no one method has been shown to reliably meet them. It is most likely that a well-formulated combination of approaches will be needed, across different forms of service delivery. The new world of electronic teaching methods shows promise for how to teach in new settings, using innovative methods, at times when children are available and interested. It is essential to continue research across many languages in order to arrive at the knowledge needed to teach children with SLI what most children acquire without explicit teaching.

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THE UNIVERSITY OF KANSAS

Mabel L Rice
Fred & Virginia Merrill Distinguished Professor of Advanced Studies
University of Kansas
Tel: +1 785 864 4570
mabel@ku.edu

Science of attraction: How to source and retain top talent in STEM

Inez Cornell at Radleys identifies what companies and universities can be doing to not only attract top talent and encourage people to pursue a career within science but how to retain employees, as well

It's no secret that the UK is falling behind the rest of the world when it comes to encouraging students to not only study but to pursue a career within some STEM subjects. The skills shortages within the life science and chemistry-specific related roles in the UK cannot be ignored; we must work towards maintaining a world-leading position for medicinal and vaccine research and development, as well as in other areas such as food and clothing technology, biomedical science, microbiology, pharmacology and forensic science.

The 2018 What do graduates do? report from graduate careers experts Prospects found that only 16.6% of chemistry graduates left university to be hired in science roles, with 19.9% entering the job market in unrelated sectors. Along with the current skills shortage within science roles, a recent report has also identified Brexit as a critical threat to job growth in the UK within this industry. One of its disruptive effects is a reduction in the number of scientists and engineers from mainland Europe looking to further their careers in the UK.

Jodie Murray, a recruitment consultant from STEM Graduates believes that graduates should be advised better on the different types of careers available to graduates. She said:

"Universities should be inviting companies for guest lectures to speak to candidates about what they do, how a science degree is useful in their company and specific roles which are available. I don't believe there is necessarily a skills shortage but more a case of graduates not being aware of all the careers options available and what roles they are qualified to pursue and enhancing their awareness will make a real difference."

The demand for staff in specific roles has also resulted in an increase in recruitment rates. Darren Orr, Director of STEM Recruitment, Solutions believes marrying up the actual requirements of what the science industry expects from new graduates and the training and experience that they receive at University is a huge issue affecting skills shortages in the industry. He believes another issue contributing to the number of vacant roles is the reluctance of employers wanting to hire graduates. He said:

"There are concerns about social maturity in young people which ultimately is a result of mistrust – this is a stigma that needs to be broken.

"Investment in new graduates and staff training has been at an all-time low. There is no contingency market and clients have opted to pay more or wait indefinitely for the right candidate. The business strategy for changing this is to fast-track staff and develop more time to planning and executing staff training."

Addressing skills shortages in the industry

The Association of the British Pharmaceutical Industry (ABPI) worked with over 30 companies to identify the areas of significant concern. From genomics to clinical pharmacology, identifying these gaps is just the first step. Employers within the industry must work towards promoting career diversity as well as the specific roles which are available. Marketing an attractive career to attract top talent is no different to marketing a new health product or TV series; you need to work at it and target the right people for the best outcomes and results.

What are the areas of most significant concern?

- **Bioinformatics and chemoinformatics** – the science of using software tools to understand biological and chemical data to help develop new treatments.

- **Clinical pharmacology** – experts working at the cutting edge of real-world data and clinical trials to help maximise the positive effects of a medicine and minimise the unwanted side effects.

- **Genomics** – sequencing and analysis of the human genome to understand how to develop new treatments for diseases.

- **Immunology** – the study of disease caused by disorders of the immune system, vital for the protection of infectious diseases.

Promoting career diversity and the roles available

There's a lot more to a career in science than stereotypes suggest and this is a message that needs to be pushed out by employers throughout the industry, as well as by allied organisations such as the British Science Association. It is important to encourage potential employees to discover the different roles the industry has to offer as well as the many sectors these roles exist in; from an analytical chemist to a pharmacologist or even a forensic scientist role, there are many different career options available, with plenty of them offering progression.

What's more, having something – or someone – to aspire to is often all that's needed to inspire change and initiate action. Employers need to spend more time ensuring positive messages are sent out and get better at celebrating and drawing attention to the achievements of scientists and the exciting things they are doing within the industry.

Take advantage of the digital world – social media channels and blogs are a great way to provide coverage and creates awareness about the work of existing scientists and the kind of opportunities that are on offer.

Attracting a new workforce

It is essential that the industry as a whole work towards inspiring more young people to pursue a STEM career. New workforces are emerging – enter Gen Z – and they work in different ways to the current and previous generations. It's clear that this demographic has very specific career expectations; we hear that they crave job security and thrive in environments where they can innovate and express their individuality – making a career in science the perfect solution, right? They are seeking meaningful jobs which will offer opportunities for advancement alongside the opportunity to learn new skills.

For the industry to attract and retain the best talent, it's essential that universities, businesses and government work harder in placing graduates into science jobs and quicker. Schools and academies can be helping too. Teaching children about science, technology, engineering and mathematics at an early age helps them to grasp fundamental concepts about the natural world, laying the groundwork and possibility for deeper learning. STEM learning doesn't have to be limited to the classroom – parents can support and aid early learning too.

"It is essential that the industry as a whole work towards inspiring more young people to pursue a STEM career. New workforces are emerging – enter Gen Z – and they work in different ways to the current and previous generations. It's clear that this demographic has very specific career expectations; we hear that they crave job security and thrive in environments where they can innovate and express their individuality – making a career in science the perfect solution, right? They are seeking meaningful jobs which will offer opportunities for advancement alongside the opportunity to learn new skills."

Adopting software solutions to enhance productivity and employee wellbeing

Gen Z is the first generation to have truly grown up with technology, so being able to use it to enhance their job prospects and develop their careers would be second nature to them. Employers can use this to their advantage, as adopting and implementing cloud-based solutions and other forms of technology will enhance productivity and encourage employee well-being.

Implementing integrated software solutions will not just benefit the younger workforce you might be considering attracting; it has unrivalled benefits for your current workforce, too. Administrative work hinders employee's ability to focus their attention on their core tasks but certain software solution systems have the ability to strip out old paper-based processes.

What's more, organisations are becoming increasingly more collaborative and teams spend more and more time delivering projects collectively, which means an internal communications system is a must. Having a beneficial infrastructure in place to support collaborative work is a benefit for the entire group. Internal communication platforms give employees the ability to see updates, track timelines, share information and easily connect from apps or computer desktops.

Considering the benefits of adopting software solutions and keeping up with technology will not only make pursuing a career in science an appealing option to the current emerging workforce but will increase efficiency and enhance productivity throughout the lab and other areas of the business.

Understand recognition is the key to retention

It is clear that employers are struggling to find, recruit and retain suitable people within specific roles within science. Recognition is the key to retaining staff – by recognising and rewarding hard work, your workers will feel valued. Feeling valued, recognised and respected is within some of the top reasons for employers staying at their current place of work, so it is definitely an aspect to take advantage of.

As well as feeling recognised and valued, career growth, learning and development is an important factor amongst talented employees – so promoting this within a career is advantageous.

By ensuring employees have the correct tools at their fingertips, they will be able to learn by themselves and identify areas where they can develop and improve. Setting targets and using technology that shows how workers are performing in real-time will help drive job satisfaction and wellbeing levels. ■

Inez Cornell
Marketing Manager
Radleys
Tel: +44 (01799 513 320
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www.radleys.com
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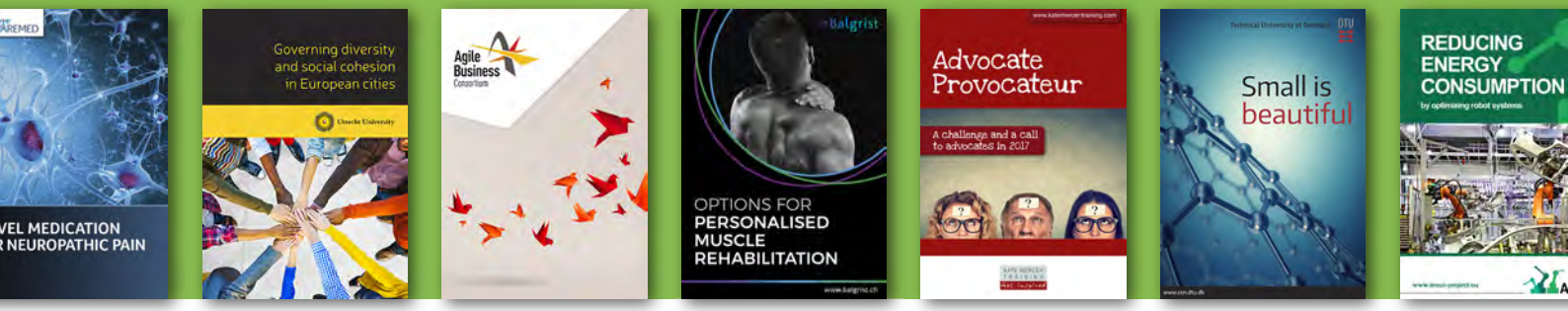

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Achieving excellence in U.S. science, technology, engineering and mathematics (STEM) education

Here, we explore the mission of the Directorate for Education and Human Resources at the National Science Foundation to achieve excellence in U.S. science, technology, engineering and mathematics (STEM) education at all levels

The Directorate for Education and Human Resources (EHR) has one primary mission; to achieve excellence in U.S. science, technology, engineering and mathematics (STEM) education at all levels and in all settings (both formal and informal) in order to support the development of a diverse and well-prepared workforce of scientists, technicians, engineers, mathematicians and educators and a well-informed citizenry. It is important that all have access to the ideas and tools of science and engineering to achieve their purpose of enhancing the quality of life of all citizens and the health, prosperity, welfare and security of the nation. In order to achieve this, a number of goals have been set by the EHR:

- Prepare the next generation of STEM professionals and attract and retain more Americans to STEM careers.
- Broaden the participation of individuals, geographic regions, types of institutions, and STEM disciplines to further close achievement gaps in all STEM fields.
- Develop a robust research community that can conduct rigorous research and evaluation that will support excellence in STEM education, which also integrates research, and education.
- Increase the technological, scientific and quantitative literacy of all Americans so that they can exercise responsible citizenship and live productive lives in an increasingly technological society.

In order to achieve the first of these four goals and prepare the next generation of STEM professionals, the Division of Graduate Education (DGE) provide funding to support U.S. graduate students and manage the development of novel, innovative programs to prepare tomorrow's leaders in STEM fields. Innovation, inclusivity, high-quality graduate education in STEM fields are priorities which DGE advocates for, and their programs help to ensure these factors. This includes the Scholarship Program (SFS), the Research Program, and the Fellowship Program (GRFP) which is critical to the overall strategy in developing the globally-engaged workforce necessary to ensure the Nation's leadership in advancing science and engineering research and innovation. It recognises and supports outstanding graduate students in NSF supported STEM disciplines who are pursuing research-based Master's and Doctoral degrees at accredited United States institutions. Moreover, DGE manages the Traineeship Program (NRT), which is designed to ensure that graduate students in research-based master's and doctoral degree programs develop the skills, knowledge, and competencies needed to pursue a range of STEM careers. The NRT Program is also designed to encourage the development and implementation of bold, new, potentially transformative, and scalable models for STEM graduate education training.

Furthermore, in February 2019 a study found that STEM achievement gaps shrunk by nearly half when faculties view intelligence as malleable, and professors adopt "growth mind-sets." "In a university wide sample, we found that all students — and black, Latino and Native American students in particular — earn significantly higher grades in STEM courses when their professors believe intelligence is a malleable quality that can be

developed over time, compared to when their professors believe intelligence is a fixed trait that cannot change very much,"[1] declared Elizabeth Canning, the study's Principal Investigator. Through this method, universities have been able to successfully broaden the participation of individuals, championing accessibility and inclusivity in STEM fields, another of the previously mentioned goals of the EHR.

The Directorate for Education and Human Resources is part of the vital National Science Foundation (NSF), which is the premier Federal agency supporting basic research and people at the frontiers of discovery in the STEM fields and was created to on the whole "promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defence."[2] The type of support it provides ranges from being a primary driver of the U.S. economy to enhancing the nation's security and advancing knowledge to sustain global leadership. In fiscal year (FY) 2019, its budget is $8.1 billion. NSF funds reach all 50 states through grants to nearly 2,000 colleges, universities and other institutions. Each year, NSF receives more than 50,000 competitive proposals for funding and makes about 12,000 new funding awards.

Just last year, the NSF awarded $50 million in grants to improve STEM education, improving the opportunity for learning in schools across 24 U.S. states and the U.S. Virgin Islands. Evan Heit, Division Director for Research on Learning in NSF's Education and Human Resources Directorate, stated, "we are delighted to support these education research and development efforts across the nation."[3] ■

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STEM Excellence: A model for equalising opportunities for STEM

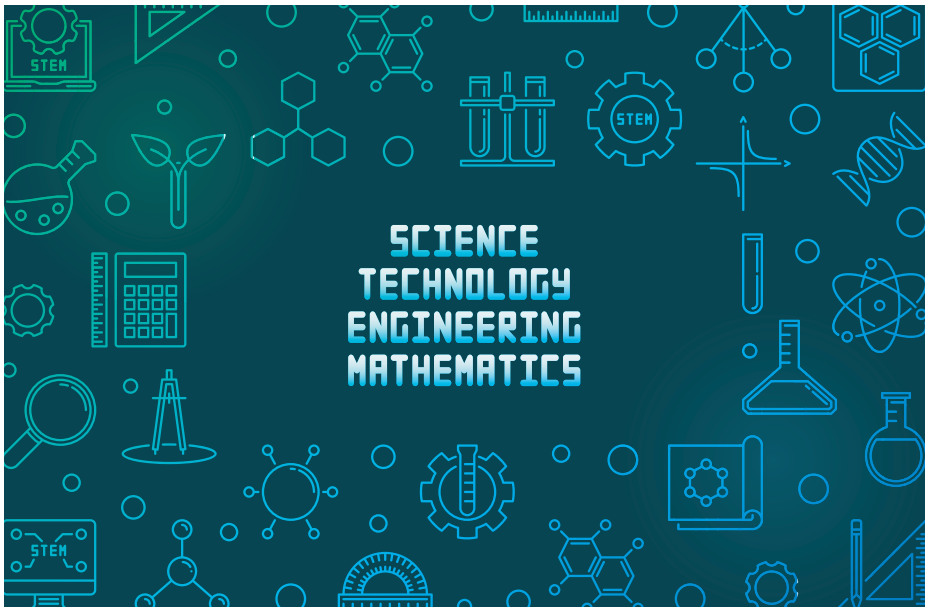
Susan Assouline, PhD, Director Belin-Blank Center for Gifted Education and Talent Development, The University of Iowa, Iowa City, IA, U.S., details a model for equalising science, technology, engineering and mathematics opportunities and in this vein, that inspires excellence

Nurturing Potential: Inspiring Excellence, our mission-driven tagline, captures the philosophy underlying the extensive student and teacher programming provided through the University of Iowa's Belin-Blank Center for Gifted Education and Talent Development. Excellence, the last word in the tagline, holds significance for multiple reasons, beginning with the origins of the word.

I thought that I knew the meaning of excellence until I heard it explained by the poet, Jorie Graham. Graham, a multi-honoured (Pulitzer Prize for Poetry, MacArthur Genius Fellowship), University of Iowa Writer's Workshop graduate and Harvard Professor of Poetry, offers both explanation and motivation.

The root of excellence – from the Greek – is not, properly, to surpass others – or to be greater than they; but, rather, to rise up naturally, to raise – as a crop is raised. The oldest root in that word – from the Greek – is that for hill. Imagine that hill. It was not placed on the landscape to make the prairie feel flat. It was not raised to make the sky tremble. Its job is to be a hill. We do not know why, but we know a hill-less world would be unbearable.

True, too, for science, technology, engineering and mathematics (STEM) programs. A world of STEM programs without excellence would be unbearable.



What does STEM excellence look like?

From our vantage point, it looks a lot like the Belin-Blank Center's recently-funded National Science Foundation (NSF) program, STEM Excellence and Leadership. Funded in 2017 for four years, through NSF's Directorate for Education and Human Resources (EHR), specifically from the EHR program for Advancing Informal STEM Learning (AISL), STEM Excellence and Leadership aligns perfectly with several of AISL's primary aims, including: broadening access to and engagement in STEM learning experiences.

STEM Excellence and Leadership includes five primary components:

1. Broadening the talent pool of students who come from under-resourced communities;

2. Drawing from the broadened talent pool to identify rural middle-school students with high STEM aptitude to participate in the STEM Excellence after-school programming;

3. Providing 96 hours of STEM after-school programming scheduled over 24 weeks, twice a week, for approximately two hours per session;

4. Offering professional development to the after-school facilitators of the program and;

5. Conducting research to understand how informal STEM learning shapes the academic and psychosocial

outcomes of rural, high-potential students, as well as to identify key characteristics of successful informal STEM learning environments for rural, high-aptitude students and their teachers.

"Our focus on excellence is somewhat unique to the American education system. Many of America's resources have been devoted to closing the achievement gap and enhancing STEM literacy, through enrichment, which is an important goal for society."

We focused on middle-school students in rural school districts for several reasons. First, Iowa is a rural state situated in the heartland of the U.S. and with an economy grounded in agriculture. Second, fewer students from rural districts, some of which are economically under-resourced, attend four-year colleges or universities compared to their urban and suburban counterparts. Rural schools are also less likely to offer advanced coursework, in part because they must contend with geographic isolation and small school sizes that often preclude the possibility of advanced coursework. Finally, we recognised the importance of working with middle-school students while their aspirations and choice of coursework are still flexible.

What have we learned?

Our method for broadening the talent pool worked. The typical gifted education program in the U.S. serves about 3 to 5% of a school's population and primarily provides a general enrichment program during the school day. Students are selected for the typical gifted program through grade-level achievement tests and ability tests. We used an alternative identification system, above-level testing, and offered this challenging testing experience to about 20% of the students who were considered high-achieving.

From that broad talent pool, about 15% were invited to participate in the after-school program; far more than the 3 to 5% identified through the typical gifted identification procedures.

We found STEM-talented students with a range of STEM talents, including emergent to exceptional.

What are we still investigating?

We continue to investigate the impact of an informal, after-school program on the overall achievement and aspirations of the students involved in the program. The after-school program takes place throughout 24 weeks of the school year and offers about 96 hours of advanced and enriched programming in STEM. We need to determine the impact of this "dose" of informal learning and whether it impacts the likelihood of taking more advanced courses and aiming high for post-secondary opportunities.

Anecdotally, we have found that participating students have increased their engagement in STEM, which is a critical first step to increasing achievement and aspirations. Teachers also felt empowered by the program and professional development.

Conclusions

Gifted education in the U.S. is undergoing a paradigm shift from in-school enrichment to talent development in domain-specific areas, such as STEM. Talent development as a philosophy aims towards excellence; as a model, it requires engagement in learning.

Our focus on excellence is somewhat unique to the American education system. Many of America's resources have been devoted to closing the achievement gap and enhancing STEM literacy, through enrichment, which is an important goal for society. However, excellence and literacy are not mutually exclusive. An either-or approach is not only unnecessary, it is also a distraction from the work needed to develop STEM talent among all individuals including bright students who attend under-resourced schools yet have the potential to demonstrate excellence through all their years of schooling. Finding talent is critical for the individual student as well as for society. This means broadening the talent pool to include high-potential students who might not typically be discovered.

Rurality has many facets, including an agricultural context of raising crops among the rolling hills of the Midwest. Perhaps Graham's explanation of excellence resonates strongly because of the connection with Iowa's rural culture. Our STEM Excellence program has examined the impact of after-school, informal programming on bright students ("to raise – as a crop is raised") who might not be discovered through traditional methods or served through traditional programs. This program inspires excellence.

The University of Iowa | Belin-Blank Center for Gifted Education and Talent Development
College of Education

Susan Assouline, PhD
Director
Belin-Blank Center for Gifted Education and Talent Development
The University of Iowa
Tel: +1 319 335 6148
susan-assouline@uiowa.edu
https://belinblank.education.uiowa.edu
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Implementing the Investigative Science Learning Environment: A focus on the first aspect of the environment and how it can be implemented

Eugenia Etkina, Distinguished Professor of Science Education at Rutgers The State University of New Jersey, continues to share her thoughts on the Implementing Investigative Science Learning Environment (ISLE), with a focus on the first aspect of the environment and how it can be implemented with students of all ages

In my first editorial, I described the Investigative Science Learning Environment (ISLE) as a pedagogical approach to teaching and learning physics at all levels (Etkina, 2015). The ISLE approach has two major goals: to engage students in the activities that mirror scientific practice while constructing and applying new knowledge and to help them grow as learners. The former means that everything that happens in the classroom and at home related to students learning of physics mirrors the activities in which practising scientists engage. The latter means that the decisions that the instructor makes while planning, enacting and assessing the instruction support student intellectual and emotional growth. In this editorial, I will focus on the first aspect of the environment and show how it can be implemented with students of all ages.

In the traditional approach to teaching and learning, the instructors are focused on what they will do to explain the material better, what experiments they will show, what problems they will assign and how they will grade student work. The students usually sit in a classroom with seats in rows facing the teacher and listen to the explanations taking notes. The students do not question the information that is supplied to them. The instructor grades them on how they understand this information and how they apply it to solve problems. The grades for student work are given once and those are recorded. The students do not have an opportunity to improve their work (in cases that they are allowed to do it, the second attempt receives a reduced grade for being second).

If you think about the practice of physics or any other science, you will see clearly how the practice of traditional teaching contradicts its every step. The heart of science is its experimental nature, the collaboration of its participants, peer review and continuous improvement of one's work. We revise and resubmit papers until they are deemed worthy of publication, we revise and resubmit grant applications. We collaborate with our peers and present our findings to large audiences that critique it. Can these practices find their way to student learning? One might argue that scientists have a lot of background knowledge, they read research papers and are trained for a long time. How can students, who are just starting to learn, engage in similar activities? It turns out that this is entirely possible.

Imagine that you walk into a classroom where students are sitting in groups of three to four around round tables. On each table, there is a small whiteboard and three to four markers of different colours. Each table has a piece of white paper. The teacher walks around and puts a streak of rubbing alcohol on each paper and asks the students to observe it. After the students watch what is happening for three to four minutes (the wet spot dries), they are invited to discuss in groups their observations without using fancy scientific terms. They write their observations on the whiteboards each using their own coloured marker. Then they lift the boards and everyone sees what the rest wrote. The discussion of the patterns emerging from their observations starts. The students say that alcohol disappeared, that the wet spot shrank, that the process happened slowly, gradually. Once the whole class agrees on these patterns, the instructor asks them to focus on the gradual aspect of the disappearance first. What could be the inside structure of the alcohol to allow it to disappear gradually, i.e. not all at once? Usually, the students say that it could only happen if the alcohol was made of smaller parts or pieces.

Now the next step of group work

comes: the students discuss in groups and put on the whiteboards all possible mechanisms (hypotheses) that could explain the disappearance of small pieces and then share these with the class using the same approach. The groups of students usually come up with several hypotheses: the paper absorbed the pieces (1), the air absorbed the pieces (2), or the pieces "jumped" out of the paper (3). Now the students have three (sometimes more) hypotheses of the mechanisms. How do we know which one is correct? Most students say: Test them! But how to test? What does it mean to test in science? Here the teacher explains that testing in science involves designing a new experiment whose outcome can be predicted using the hypothesis under test. If the predictions based on different hypotheses for the same experiment are different, it is a good experiment, if they are the same, the experiment will not help distinguish between different hypotheses.

The groups get together again to brainstorm possible experiments. They come up with the following experiment quickly: put the wet paper on a scale. If (1) is correct, the reading of the scale will not change as the paper dries. If (2) and (3) are correct, the reading will go down and eventually be the same as for the dry paper. The experiment is easy to perform and the outcome matches the predictions based on (2) and (3). (1) is rejected and (2) and (3) are not.

How to test the hypothesis (2) that involves air? Usually, the students suggest wrapping wet paper in a plastic wrap to prevent interaction with air. If (2) is correct, the paper should not dry but it should not dry also if (3) is correct. Thus, the experiment will not allow differentiating between these two hypotheses. At this moment, the instructor leads a discussion of what makes a good testing experiment. The search for new ones goes on.

In our experience, the most attractive hypothesis for the students is that air absorbs the pieces of alcohol (2). How can they test it? Eventually, a group of students comes up with putting wet paper under a vacuum jar and have another one, similarly wet outside. If air takes alcohol parts, then the paper under a vacuum jar should dry slower than outside. If the pieces jump out (3), then removing air should not affect the rate of drying. This experiment is easy to perform if you have a jar or use the video, here. To students' surprise, the paper inside the jar dries faster! The "air" hypothesis is disproved. What is next? Testing the hypothesis of moving pieces. We leave the readers to observe the experiment and come to the conclusions themselves. The moving parts hypothesis is not rejected.

In summary, the students observed a simple experiment (drying alcohol), worked in groups to come up with two patterns: disappearing (1) of alcohol occurs gradually (2) devised one explanation for pattern 2 and several for pattern 1, tested them in multiple experiments and rejected all explanations for (1), except the motion of little pieces of alcohol. To summarise, the students on their own constructed the concept of the particle nature of matter and the idea that these particles are moving. These two ideas are the foundations of the kinetic molecular theory – the most fundamental theory of nature. The process through which the students discovered these fundamental ideas follows the ISLE (Investigative Science Learning Environment) approach.

Note, that in the process described above, the students participated in most important science practices: they observed natural phenomena, devised multiple explanations for them and systematically tested them with the purpose of ruling out not proving. They worked collaboratively, shared their ideas and continuously improved them. They were not looking for correct answers but were engaged in an authentic scientific process. This is just one example of how one can bring real science into the classroom. We have developed similar sequences for all concepts of introductory physics (Etkina, Brookes, Planinsic and Van Heuvelen, 2019). In my next editorial, I will address the second foundational idea of the ISLE approach – supporting student growth as learners.

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Eugenia Etkina
Distinguished Professor of Science Education
Rutgers The State University of New Jersey
Graduate School of Education
Department of Learning and Teaching
Tel: +1 831 295 2301
Eugenia.etkina@gse.rutgers.edu
https://gse.rutgers.edu/eugenia_etkina
http://www.islephysics.net
http://www.islephysics.net/pt3/
https://sites.google.com/site/scientificabilities/
http://pum.islephysics.net/

Three ways EdTech will benefit this century's learners

Felicity Parsisson, Learning Designer at FutureLearn, explains three ways in which EdTech will benefit this century's learners

The rise of EdTech as both a medium and a method of instruction is not to be underestimated: from interactive whiteboards and shared screens to flipped classrooms and Massive Open Online Courses (MOOC)s, the 'EdTech' moniker appears in every possible educational setting. There are as vast and diverse an array of technologies, tools and pedagogies falling under the EdTech label as there is a vast and diverse spectrum of learners and educators using it. With 66% of millennials and 59% of Gen Z surveyed by Pearson agreeing that 'technology will transform how college students learn in the future', it seems clear that the use of technology in teaching and learning contexts is not just predicted: it is expected. Coupled with the majority of Gen Z stating a preference for learning through YouTube videos (59%), as opposed to printed books (47%) and the explosion of MOOCs documented by Class Central (an estimated 101 million learners as of their 2018 research), and it becomes apparent that EdTech is already an important part of the learning landscape. With that in mind, this article considers three key functions of EdTech for this century's learners.

EdTech as a way to increase access, widen participation and expand skillsets

In 2018, the World Economic Forum warned that as the nature of work changes, by 2022, 54% of the world's employees will require significant reskilling. Many key skills for today and tomorrow's workforce centre on technology, particularly in areas such as data science and robotics; and the demand for skilled workers drastically outstrips supply. Similarly, The European Commission has suggested that 37% of European workers lack even basic digital skills. It will no longer be possible to simply pay for workers with premium skills – there simply won't be enough people with those skills around to fulfil the positions required.

Felicity Parsisson

This is where EdTech and online education can help. In the UK, government-backed initiatives like the Institute of Coding (IoC) and the National Centre for Computing Education (NCCE) are using online platforms to tackle the issue head-on. The IoC was formed to respond to the UK's digital skills gap and has created an online course catalogue to help guide learners in their journey to a digital career. This online catalogue brings together a wide range of digital skills courses that are being offered by the IoC's 30+ partner universities and industry educators. The IoC not only addresses today's skills gap by upskilling in 21st Century skills but also aims to educate about relevant careers, expanding their reach and making them both attractive and accessible to a wider and more diverse group of learners (and future workers). Meanwhile, the NCCE operates at a grassroots level by teaching teachers the skills needed to ensure every child in every school in England has

access to world-leading computing education, indeed, they are an example of an organisation with many online courses to help in that mission.

EdTech as a way to allow differentiation and choice

Most classes have a relatively varied learner profile – that is, not every learner is going to be at the same level, have the same method of approaching tasks, have the same educational background or emotional attitude towards what it is they are learning. Coupled with affective factors that might impact a student's progress (home environment, work pressures, physical limitations), EdTech can help to support both teachers and learners personalise the learning experience.

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Advances in EdTech and online learning platforms can support educators and empower learners through more easily incorporating addendums to the core curriculum in a digital learning environment. Simply linking to further reading or the creation of easy-to-share extra practice activities, for example, can provide the support or challenge needed to engage students and support learning, whereas choice could be given through learners deciding themselves how they wish to evidence their learning and to so with a variety of EdTech tools. Videos can show step-by-step ways of approaching a task – for example, setting up the stages of a science experiment for learners to check their work against.

Another way in which EdTech can allow for differentiation and choice is its suitability for the flipped classroom, where learners spend 'homework' time outside of class more independently preparing for their face-to-face lessons. This directed but self-paced method means learners have more time to get to grips with key concepts and ideas at home, freeing up class time for deeper application of their learning or time to try practical tasks out.

EdTech as a way to support, connect and engage

The opportunities for diverse, self-selecting communities of learners on MOOCs and other online platforms far surpasses that which could be achieved by even the largest school or university campus. With Pearson's report demonstrating that Gen Z in particular value diverse relationships, it is clear that the opportunities afforded by the global reach of learning online can facilitate this. But there's much more to connecting and engaging than simply learning online with a dispersed international cohort. Products such as Microsoft Teams or GSuite can be used successfully to make light work of collaborative projects for learners in a school class, giving students tools to plan, draft, edit and produce work with ease. Specific products also exist to help teachers easily monitor learners' progress, while online tutorials can be more interactive and productive than face-to-face ones as teachers and learners take turns sharing screens or fulfilling the presenter role.

Considering these three key ways which EdTech can impact today's learners is not to suggest that all teaching and learning will become fully tech-based, or that face-to-face teaching will be obsolete. Technology without pedagogy is simply another teaching tool, and a productive, relevant and useful educational experience is much more than its composite parts, but EdTech can bring to life ideas and experiences in a way that adds richness, practical application and skills development to the curricula, while serving to inspire the data scientists and automation experts of tomorrow. ■

Felicity Parsisson
Learning Designer
FutureLearn
support@futurelearn.com
www.futurelearn.com
www.twitter.com/FutureLearn

Education: Global citizenship for human flourishing

Dr Anantha Duraiappah and Nandini Chatterjee Singh from UNESCO, Mahatma Gandhi Institute of Education for Peace and Sustainable Development, share their views on the importance of global citizenship for human flourishing

In 2015, the United Nations Sustainable Development Goals (SDGs)1 – a universal call to action to end poverty, protect the planet and ensure that all people enjoy peace and prosperity – were adopted by 193 member states of the United Nations. Of the 17 SDGs, SDG 4, target 7, is focused not just on providing education, that is 'Quality, Inclusive and Equitable Education' – but also seeks to build peaceful and sustainable societies.

To achieve SDG 4.7, education needs not just to be redesigned but its very purpose needs to be reconsidered. Why should education be revisited? The world is going through a demographic overhaul. Emigration and immigration patterns are creating societal compositions that are unprecedentedly heterogenous – composed of diverse races, classes and cultures. At the same time, a steady deterioration in the Global Peace Index since 2008 (GPI, 2017), a steady increase in internal conflicts 2016, continued decline in empathy (Konrath et al, 2010) and increased mental stress and depression in children (WHO report, 2017) have highlighted the failures and inadequacies of the current education system.

Education needs to be repurposed and redesigned to build not just human capital for economic growth but to create global citizens for human flourishing. We describe global citizens as lifelong learners who possess the critical consciousness to drive 'active citizenship', to recognise the inherent interconnectedness and dignity of all life and instil the values of acceptance, equality, respect for diversity, empathy and compassion.

To redesign education with this new purpose, we turn to recent advances in the neuroscience science of learning. Recent findings from brain research have demystified the learning process, facilitating new understandings of how learning happens and can be shaped. The human brain has emerged as a remarkable

organ which has specialised tissue for both intellectual and emotional learning. The outermost layer of the brain in humans is the neocortex which is involved in building the intellect and includes processes like decision making, sensory perception, generation of motor commands, spatial reasoning, conscious thought and language. Older, inner structures of the human brain also called the limbic cortex, process emotion, goal setting, motivation and self-control (Gazzaniga, 2008). The neo-ortex is densely connected to the emotional cortex and, thus, all learning is hugely influenced by emotion. Most importantly, we now know that the brain is malleable and can be trained because of a process called neuroplasticity. Neuroplasticity is defined as the ability of the brain to form and reorganize connections, especially in response to learning (Draganski et al, 2004).

> "Education needs to be repurposed and redesigned to build not just human capital for economic growth but to create global citizens for human flourishing. We describe global citizens as lifelong learners who possess the critical consciousness to drive ' active citizenship', to recognise the inherent interconnectedness and dignity of all life and instil the values of acceptance, equality, respect for diversity, empathy and compassion."

Thus, to build global citizens, education curricula needs to build not only intellectual skills of critical thinking, rational and logical decision making but also includes Social and Emotional Learning (SEL) through which individuals recognise and regulate emotions, identify positive purpose, demonstrate empathy for others, take compassionate action and promote human well-being. Research now shows that social and emotional learning can be taught in the classroom, just like literacy and numeracy and that explicit inclusion of SEL fosters happier motivated students who exhibit pro-social behaviour. Prosocial behaviour is voluntary social behaviour that represents a broad category of actions that are generally beneficial to other people and to the ongoing political system (Piliavin et al. 1981). Thus, prosocial behaviour promotes human flourishing and has been shown to be altruistic and motivational and recent reports have indicated that specific cultivation of prosocial behaviour may be a necessity to achieve the SDGs (Asah and Chatterjee Singh, 2019).

Dr Anantha Duraiappah
Director, UNESCO MGIEP

Nandini Chatterjee Singh, PhD
Senior National Programme Officer

We argue for a revolution in education – one that is restructured to promote global citizenship rather than only cater to the narrow political or economic agenda of countries. The pedagogical processes of education need to instil in learners the inherent interconnectedness and dignity of all life and create values of acceptance, equality, respect for diversity, empathy and compassion in us. Education-based on this approach can not only nurture the potential of the present generation but also future generations to generate peaceable and sustainable future societies consonant with a far-reaching vision of SDG 4. ■

Dr Anantha Duraiappah
Director, UNESCO MGIEP

Nandini Chatterjee Singh, PhD
Senior National Programme Officer

UNESCO Mahatma Gandhi Institute of Education for Peace and Sustainable Development (MGIEP)
Tel: +91 11 2307 2356 60
https://mgiep.unesco.org/
www.twitter.com/UNESCO_MGIEP

Keeping our democracy true: Foreign information interference and forward-looking countermeasures

Vassilis Ntousas from the Foundation for European Progressive Studies explores an aspect of politics that concerns keeping our democracy true when it comes to foreign information interference and forward-looking countermeasures

The last editorial of the print edition of the Independent newspaper contained a powerful quote, increasingly emblematic of our times "the truth is hard, expensive and sometimes boring, whereas lies are easy, cheap and thrilling." This has always been true to an extent, but the level of weaponisation of truth in today's fiercely contested information environment ails our democracy and our democracies perhaps in an unprecedented fashion.

Malign (state and non-state) actors have taken advantage of the rise of new media and digital technologies, exploiting loopholes that exist in the intersection behind this set of technological advancements and our traditional model of political and social organisation. These actors have realised over the past decade and a half that this new digital toolkit is a relatively easy, far less costly and much more powerful instrument, perfectly capable of exploiting our human weaknesses and of polarising and dividing societies.

The goal is clear. Usually disguised as legitimate and trustworthy content, disinformation has often exploited the viral power of social media and the echo chambers that digital liked-minded communities often operate within, at times leading to much higher and broader distribution rates than actual news. It has thrived on the polarisation many of our societies are facing and it has served to entrench further these echo chambers and amplify misinformation. In such an environment, as Orwell predicted, when we can't decipher what is real and what is not democracy, its ethos, norms, institutions and foundations, are severely challenged. The combined result of this is the subversion of the normalcy of political life, the sowing and encouragement of discord and the amplification of fissures, divisions, suspicions and distrust within our societies. It is these fissures that have increased and sustained the susceptibility of our societies to outside interference.

> "In order to fully safeguard our democracies, we also need to ensure that we exhaust all means available at our disposal to tackle the underlying problems making our societies susceptible to such efforts. It is easy and at times lazy to blame foreign actors for everything negative happening domestically, but have we worked enough to patch up or heal our internal divisions, have we exerted the maximum of our oversight role and have we closed off all possible or imaginable loopholes?"

A measured, imaginative response

How is democracy and for that matter, our democracies to respond against these challenges?

To react appropriately, we need to make sure that we are neither underestimating the threat nor overestimating it. Take Russian actions in this domain for example. For sure, the Kremlin's efforts have been characteristic of an authoritarian regime's intent to act in this way to discredit liberal democracy and its component elements. Nonetheless, Russian influence operations might be real, but they are neither as detrimental nor as effective as they first appear. Lumping everything under the heading of 'Russian-related efforts to subvert our democracies' may lead to the spread of the belief that Russian influence operations are always ubiquitous and wildly successful. On the contrary, they often

are inept and poorly organised. This is not to downplay what is at stake here and the threat level involved. It is simply to underline the importance of having a realistic sense of threat perception.

In order to fully safeguard our democracies, we also need to ensure that we exhaust all means available at our disposal to tackle the underlying problems making our societies susceptible to such efforts. It is easy and at times lazy to blame foreign actors for everything negative happening domestically, but have we worked enough to patch up or heal our internal divisions, have we exerted the maximum of our oversight role and have we closed off all possible or imaginable loopholes?

Finally, we also need to remember that this is as much an exercise about analysing what went wrong (or right) in 2016, 2017, or 2018, as much as it is about setting the rules about it not happening, or happening differently in 2019, 2020 and so on. Simply catching up cannot be the basis for sustainable, forward-looking strategies to address the challenges posed; models and frameworks that respond to the needs of tomorrow as much as to the needs of today must be established. There are critical areas where this logic must be urgently applied: we need to now start designing new electoral laws that are in sync with the digital age, we have to take a leap forward in how we improve digital literacy, and we must address the public policy gap that exists by commissioning more comprehensive, systematic, and robust research to explore the correlation between interference efforts and their impact on suspicions, emotions and divisions.

In this endeavour, Europe must inescapably raise its level of ambition. The GDPR legislation has shown the potential of the European Union (EU) being a leader in digital matters and enforcing a stricter regulatory framework in how the big tech companies operate, but with a large majority of internet users across the continent being concerned about disinformation in pre-election periods, this is clearly not enough. Similarly, recent efforts to boost the funding of the East StratCom Task Force, created in 2015 to address Russia's ongoing disinformation campaigns, are a good step but we need to be much more audacious in our approach. Finally, building cyber resilience is neither a spectator sport nor a solitary one. In this regard, resuscitating the transatlantic axis is key; the EU and the U.S. should be the international standards and norms setters in this regard. Combining the regulatory weight of the U.S. Government with European leadership in issues like privacy should create the necessary gravitas for meaningful, positive change globally as well as powerful and costly countermeasures.

Ben Franklin, a polymath and one of the founding fathers of the U.S. once referred to democracy as: "two wolves and a lamb voting on what to have for lunch." In a world awash with disinformation, one might be tempted to slightly update this great quote by adding that democracy is two wolves with a keyboard and a lamb voting on what to have for lunch. The stakes could not be higher - thwarting digital authoritarianism should, therefore, be an absolute priority, not least for the next European Commission.

As thrilling as it might be to believe otherwise, succeeding in this endeavour will be important not only for the meaningful political battles that are being fought right now, but perhaps more so, for the kind of politics and the kind of democracies we will be functioning within in the years and decades to come. ■

This piece contains excerpts and ideas from a larger research piece to be published by the end of the year by FEPS.

Vassilis Ntousas
Senior International Relations Policy Advisor
Foundation for European Progressive Studies (FEPS)
Tel: (+)32 22 34 69 00
vassilis.ntousas@feps-europe.eu
www.feps-europe.eu
www.twitter.com/FEPS_Europe
www.twitter.com/VNtousas

Progressive state leadership today: Part 2

Richard Beardsworth, Professor and Head of School, School of Politics and International Studies, University of Leeds, provides the second article of a series on progressive state leadership

Things are moving quickly. Since I last wrote about progressive state leadership earlier this year for Open Access Government, there have been two important normative shifts in the politics of the Western world. The first is the consolidation of populist nationalism, most evident for those residing in the UK in the way in which a 'no-deal' Brexit has become the default norm. The second is the normative shift regarding climate change.

Since the Intergovernmental Panel on Climate Change's special report of October 2018 (advising a maximum 1.5 °C average global temperature increase), perceptions around the social, economic and political importance of climate change mitigation and adaptation have decisively shifted – in civil society, across political parties, and in branches of government. These two normative shifts are set to clash, as we see presently in the United States and Brazil. State leadership is/will become vital in deciding the direction of these clashes. In the context of this *quickly moving history*, it is important to keep addressing the issue of progressive state leadership.

My last article underlined the mind-set of such leadership: re-framing the question of borders, of national interest, of sovereignty, etc. so that a new internationalism is borne *on the back of* an alignment of domestic and global interests and values. This second article asks what the progressive agenda is shaping up to be for progressive state leadership. This entails three analytical/normative questions: First, what is understood as 'progress' today, and therefore what is it to be 'progressive' today? Second, what is a relevant 'progressive agenda'? Third, what does it mean to lead on this agenda?

What is progress, what is it to be progressive today? The concept of progress was born in the 18C Enlightenment (although it has deep historical

roots). History was considered a vehicle for the greater emancipation of humankind. This understanding of history has closed: decolonisation questioned its narrow conception of emancipation; two world wars and the ever-present threat of a nuclear crisis have undermined claims to greater peace; and climate catastrophe uproots the assumptions of modernity and modernisation processes.

As a result, the idea of 'progress' must be thought and practiced differently. Amidst re-assessments rehearsed today in universities, think tanks, public reports and the media, I emphasize two lines of thinking here: A sense of limit and an understanding of relations that go wider than those between humans. Progress today entails modesty and caution regarding the place of the human in the world. To be ambitious is not to throw caution to the winds, but, precisely, to *open up a world within limits*. What does it mean to be 'progressive' in this context of limits? The *progressivism* structuring U.S. politics from 1908 to 1918 has certainly regained relevance in our populist age: to place 'the people' above specific interests; to redress huge inequalities of condition and power; to consider government as a tool of economic and social change, providing the conditions of the common good, collective purpose and equality of opportunity (set against an excessive individualism and consumerism). These norms are returning. *If aligned with the idea of a world of limits*, they are today (again) progressive. Maria João Rodriguez argues that it is the millennials (born between 1980 and 2000) that are most sensitive to this alignment. The last six months also shows a growing political sensitivity among post-millennials (School Strikes for Climate, etc.). Progress is about the future; it is inter-generational. The idea of progress emerging from, and for, the younger generations is that of building a world of limits.

What, then, is a progressive agenda today? Climate change and planetary sustainability are not simply at the forefront of a progressive political agenda. They articulate the terms *through which* economic, social and political progress is to be thought and practiced in the first place. Responsibility towards climate change, implementing planetary sustainability, provides consequently the overall normative framework within which progressive goals can be settled. This point has three major implications.

First and foremost, to tackle domestic inequality requires at the one and the same time a global approach to social, economic and environmental problems: economic regionalisation and localisation works, in other words, with a spirit of internationalism that seeks institutionalised cooperation among countries and peoples. The contemporary nationalist opposing of the national to the global (or inversely previous neo-liberal opposing of the global to the national) makes no sense within the progressive practice of a world of limits. Planetary sustainability requires, together, the reorganisation of national economies towards the sub-national *and* increasing institutional articulation between the more and less vulnerable nations on the planet. Linking in this non-oppositional manner the economic, the social and the environmental will increasingly define, I suggest, the progressive agenda.

Second, this agenda must be therefore concretely local and global, re-inscribing the legitimate concerns of populist nationalism (inequality, identity) within economies and cultures of sustainable lifestyles. The emerging behavioural norms of 'well-being' and 'respect for biodiversity' suggest progressive orientation here. Lastly, set against the contemporary politics of fear and closed borders, this agenda can nurse social anxiety towards more shared political transformations.

Third, and in conclusion, what does it mean to lead on this agenda? To push for progress towards a world of limits at this ideological time requires particular states leading in the rapidly changing, but uncertain international order. As public officers of the United Nations all too often emphasise, the *time* for addressing global challenges like climate change is very short, but the *scale* of operations to do so is very large. Drawing on their capacities as states, progressive states are those that bring together *time and scale*. To do so, they forcefully align national and global interests, tailor the global to the local and scale up the local to the global so that a world of limits emerges as an attainable horizon of human progress. For this, particular states must lead by example; progressive state leadership is now required in this sense.

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Richard Beardsworth
Professor and Head of School
School of Politics and International Studies,
University of Leeds
Tel: +44 (0)753 920 987
r.beardsworth@leeds.ac.uk
www.twitter.com/POLISatLeeds

Cities are partners in a common future for Europe

Anna Lisa Boni, Secretary General, EUROCITIES, argues that cities are partners in a common future for Europe

European Union (EU) leaders are busy making plans. We have 'a new strategic agenda' until 2024, new MEPs sitting in the European Parliament, a new European Commission college that offers gender parity and ongoing discussions on possible new portfolios and areas of work.

I'm also pleased to see the first-ever woman taking on the job of European Commission President, which is certainly a positive change.

Meanwhile, the EU has essential promises it must keep. The Paris Climate Agreement for one. We cannot impinge the health and prosperity of future generations when we have, in our hands, the knowledge and capability, to do otherwise.

Existing challenges must similarly be tackled. With one in four Europeans at risk of poverty or social exclusion, it is now more important than ever to ensure social rights for all people and preserve social cohesion.

There are many other issues facing Europe, including those rising up the agenda such as security. In order to deliver on the majority of these agendas, European and national leaders must be prepared to work closely with city administrations, where most people live.

Anna Lisa Boni, Secretary General, EUROCITIES

Europe depends on its cities

Local authorities are responsible for the implementation of more than 70% of EU rules. From finding housing for refugees to meeting climate change targets, we make the EU a reality for people every day. It's clear that the future of Europe depends on how it engages with its cities.

Cities across Europe are committed to transition to a greener, more sustainable and inclusive future by working with citizens and collaborating in partnerships. We ask European leaders to work with us to adopt and implement the vision of a carbon-neutral Europe by 2050. This should include policies directed towards cleaner and fewer vehicles on our streets, investment in public transport networks, support to scale-up energy transition in urban areas and a decisive move towards a circular economy.

Cities ability to manage the digital transformation and optimise the use of new technologies is vital for a more

inclusive, efficient and fair Europe. European leaders should work with us to boost the digital transformation across the EU by supporting cities' efforts to develop, test and scale-up digital solutions that help provide better public services, while also empowering people to participate and benefit.

Cities are taking the lead in the fight against poverty and social exclusion across Europe. We need a fairer, more equal and inclusive Europe that puts people at its centre. EUROCITIES new initiative 'Inclusive cities for all: Social rights in my city' takes the spirit of the European Pillar of Social Rights to deliver concrete actions on the ground. This includes financial pledges from cities, showing that the local level is ready to engage with other levels of government to create a future that leaves no one behind.

A future that works for people

Through EUROCITIES 'city leaders agenda for Europe', we are asking European and national leaders to work with cities as partners to bridge the gap between Europe and its citizens. Together we can build an ambitious agenda for Europe that works for its cities and people.

While significant achievements in recent years, such as establishing an urban agenda for the EU, show the growing role of cities in EU decision making, more can be done.

To strengthen leadership on urban matters in the EU, we need high level recognition of the importance of urban affairs in the European Commission to ensure an ongoing dialogue with city leaders, strategic direction and stronger coordination of EU policies for cities.

The future success of EU-urban cooperation would further benefit from the secretariat general taking the leading role in overseeing the Commission's engagement in the urban agenda. This would better reflect the cross-sectoral approach to policymaking adopted by city administrations

The more that EU leaders and other levels of government are willing to engage directly with city leaders, the more policy at all levels will create results that matter for people. Working with cities means working with people. ■

EUROCITIES is the political platform for major European cities. We network the local governments of over 140 of Europe's largest cities and more than 40 partner cities that between them govern some 130 million citizens across 39 countries. www.eurocities.eu

Anna Lisa Boni
Secretary General
EUROCITIES
Tel: +32 2 552 0888
info@eurocities.eu
www.eurocities.eu
www.twitter.com/eurocitiestweet

The early history of public health from an evolutionary perspective

Romola Davenport and Richard Smith, Cambridge Group for the History of Population and Social Structure, Department of Geography, University of Cambridge, explore the history and evolution of public health, in this article

Global life expectancy has risen over the last two centuries from perhaps 30 years in 1800 to over 70 years today. While for most of the world's populations these improvements occurred in the twentieth century, and especially after 1950, the process of improvement was much more protracted in now-developed countries, and the first signs of the so-called mortality transition can be traced to the mid-eighteenth century in northern Europe. These early origins pose a puzzle because they predated major investments in public health (which occurred in Britain from the mid-nineteenth century at the earliest) and medical advances (which with the exception of smallpox vaccination, were associated with developments in germ theory and aseptic techniques from the 1870s onwards).

"Paul Slack argued in the case of plague that the steps required for the import of plague-infected rodents and fleas into English ports, and for the subsequent propagation of a human epidemic, constituted a tenuous chain of transmission that could be disrupted even by relatively incomplete or crude quarantine measures."

Moreover, in England at least, these early improvements coincided with very rapid growth of especially industrial, manufacturing and port towns and the urban disamenities associated with these environments. Yet in England the largest improvements in survival in the period 1750-1820 occurred in towns.

A Wellcome Trust funded project to investigate the early origins of the 'Mortality Revolution' in British towns has provided some surprising insights into these early gains. Analysis of the diseases that diminished in importance before 1850 in the English population revealed that these diseases were generally the most lethal (Figure 1). Figure 1 depicts schematically the timing of declines in major infectious causes of death between the seventeenth and the mid-twentieth centuries, together with broad estimates of disease lethality as measured by the percentage of those infected who died as a result.

Bubonic plague, which disappeared from Britain after the 1660s, was associated with extremely high case-fatality rates, with between 20 and 60% of those infected dying. Its eruption into medieval Europe as the 'Black Death' was associated with sustained population falls of an estimated 30-50% in western Europe, and it continued to wreak havoc on urban populations until the late seventeenth century, killing an estimated quarter of London's population in 1665. Typhus, which under its pseudonyms 'famine fever', 'ship fever' and 'gaol fever' was a major cause of the high mortality historically associated with harvest failures, warfare and other causes of social dislocation, had largely disappeared from England by the mid-nineteenth century. Malaria (Plasmodium vivax) was a major cause of high mor-

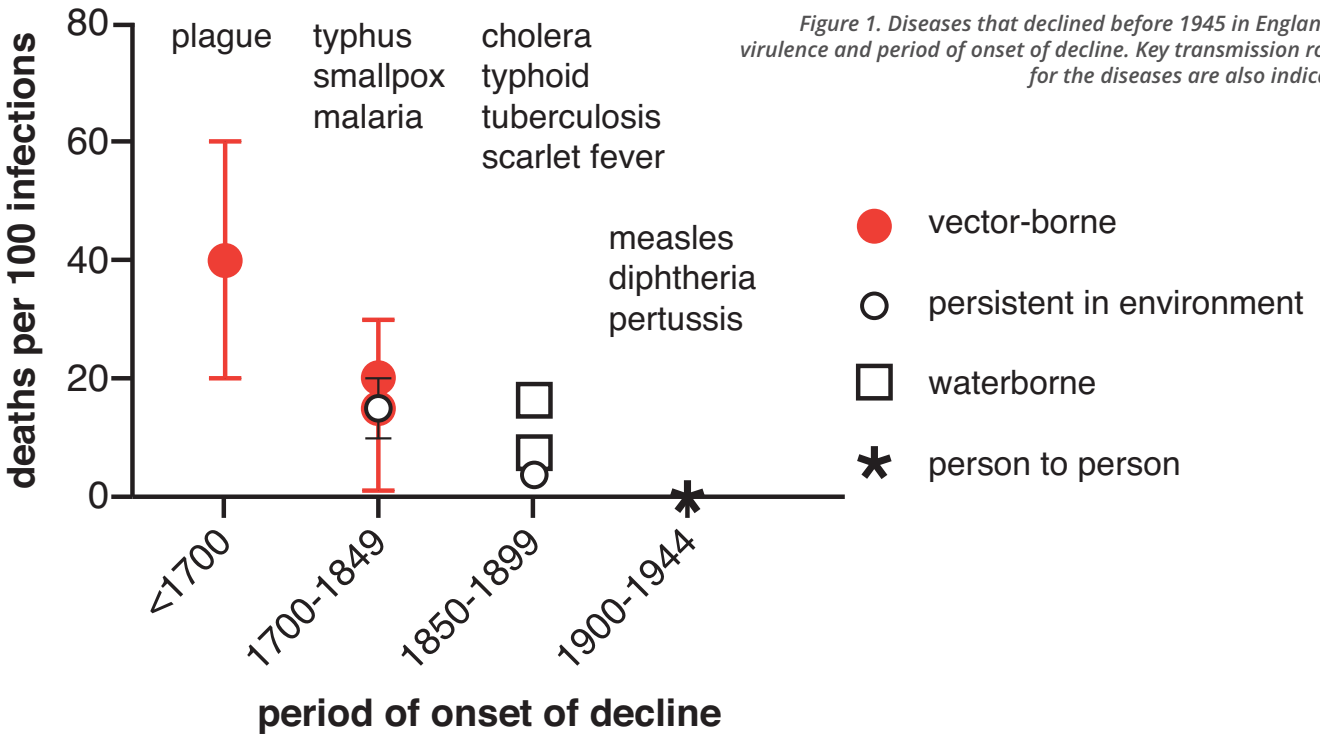

Figure 1. Diseases that declined before 1945 in England, by virulence and period of onset of decline. Key transmission routes for the diseases are also indicated.

tality and ill-health in low-lying areas of southern and eastern England until the early nineteenth century.

Smallpox is estimated to have caused 5-10% of all deaths in England in the eighteenth-century, and accounted for 20% of all burials in mid-eighteenth-century Manchester. However, following the introduction of vaccination from 1800 smallpox was reduced to a minor cause of death, accounting for roughly 1% of deaths by 1850. Pandemic cholera spread across Europe in the 1830s and returned in repeated waves across the nineteenth century, however, Britain was precocious in preventing major outbreaks after 1866.

By the mid-nineteenth-century the most terrifying epidemic diseases had almost disappeared from England, and infectious disease mortality patterns were dominated by 'childhood' diseases such as measles, scarlet fever, whooping cough and diphtheria, by tuberculosis, and by respiratory diseases. This represented a major change in the structure of mortality, from a regime where even young and robust adults were at risk of epidemic diseases and wealth conferred little protection, to a regime characterised by increasing social inequalities in life expectancy, and the concentration of mortality at the extremes of life, in early childhood and old age. These changes occurred largely before the development of the Victorian death registration system and the systematic collection of vital statistics, and therefore, the mid-nineteenth century is often treated as reflecting the traditional pattern of mortality before the onset of the modern 'Mortality Revolution', rather than a novel and probably unprecedented stage in the development of modern disease control.

What explains the pattern in Figure 1? Why did less virulent diseases take longer to control? Theories of the evolution of virulence and pathogen life histories developed in the past forty years in the field of evolutionary biology offer insights into these historical trends. In the case of diseases that are primarily transmitted directly from person to person, such as measles, chickenpox and whooping cough (pertussis) and most other respiratory pathogens, then there is a trade-off between transmission and virulence. Briefly, for transmission between hosts to occur, the infected host must contact a susceptible second host. This is less likely when the disease is virulent enough to render the host bed-ridden, hideously disfigured or, more obviously, dead.

Therefore, there is natural selection in such cases for a mild infection that leaves the host able to walk about and interact with others. However, virulence is also selected for, because it is associated with high levels of pathogen reproduction within infected hosts. High reproduction rates favour

the survival of the pathogen against host defences, promotes the success of more rapidly growing lineages, and increase the volume of pathogens coughed up or otherwise excreted. In the case of smallpox death often occurred due to the blocking of capillaries by the sheer volume of viral smallpox particles.

Importantly, the trade-off between within-host reproduction (associated with virulence) and transmission between hosts is lessened, or absent, where alternatives to person-to-person transmission have evolved. This is especially evident in the case of bubonic plague, where humans are not a normal part of the cycle of disease from flea to rodent to flea and, therefore, the survival of the human host has not been subject to much, if any, evolutionary selection. In the case of Asiatic cholera, the very virulent nineteenth-century cholera subtype, infection rendered the victim prostrate within hours.

However, the bacteria reproduced in very high numbers in the gut and released toxins that made the intestines leaky, causing massive fluid loss that carried the pathogens onto clothing and bedding as well as faecal discharges, and thence into watercourses when these were washed or disposed of. Where there was inadequate separation of drinking water and sewage then this proved a very effective transmission route, despite the death of the victim. Current strains of cholera are much milder, and the evolutionary biologist Paul Ewald, a key exponent of the role of life histories in trade-off theory, has argued that this reflects selection against waterborne transmission and in favour of person-to-person transmission as a result of the enormous improvements in water quality since the mid-twentieth century.

> "Smallpox is estimated to have caused 5-10% of all deaths in England in the eighteenth-century, and accounted for 20% of all burials in mid-eighteenth-century Manchester."

The high potential virulence of pathogens with alternative transmission pathways may have been associated with early control, at least in an English context, precisely because these transmission pathways were relatively easy to disrupt (compared with highly infectious 'crowd' diseases).

Paul Slack argued in the case of plague that the steps required for the import of plague-infected rodents and fleas into English ports, and for the subsequent propagation of a human epidemic, constituted a tenuous chain of transmission that could be disrupted even by relatively incomplete or crude quarantine measures (although much more stringent measures were required in continental Europe, where import was much more frequent).

Similar arguments can be applied to other lethal diseases; that is, the chain of transmission was tenuous to be broken by early public health interventions, or as the unintended consequence of other changes such as the drainage of swampy land. These processes probably occurred more readily, and at less expense, in England than in continental Europe for example because its island status reduced the frequency of disease importation, and in the case of malaria, it was a relatively marginal environment for mosquitoes.

If this theory is correct, then it implies a large role for early public health interventions in the first stages of mortality decline. These interventions have probably been under-appreciated in the history of medicine and health because they were crude and incomplete compared with later efforts.

However, we suggest that these early interventions were directed at the 'low-hanging fruit', and yielded disproportionately high returns. As the most lethal diseases were controlled then much greater efforts were required to reduce mortality from very infectious but less lethal diseases of childhood and poverty. Similar processes were probably at work globally in the first half of the twentieth century, but again the patchy availability of data makes them difficult to discern.

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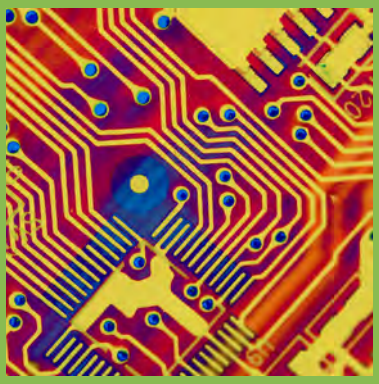
UNIVERSITY OF CAMBRIDGE

Richard Smith
Emeritus Professor of Historical Demography and Geography
University of Cambridge
Tel: +44 (0)1223 333 182
rms20@cam.ac.uk
www.campop.geog.cam.ac.uk/research/projects/migrationmortalitymedicalisation/









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The housing market: Social interaction in mixed building blocks – finding the 'magic mix'

Gideon Bolt & Rutger Pierik from Utrecht University share their expert thoughts on social interaction in mixed building blocks when it comes to finding the 'magic mix' in the academic literature concerning the housing market

Creating mixed communities to counter the negative effects of segregation has received much scepticism from the perspective of academics. Bolt & Van Kempen (2013) distinguish between three types of critical arguments in the literature. The first argument is that mixing does not address the real problem. Mixing policy is a way of treating the symptoms of inequality rather than the causes. The second argument is that mixing has negative side effects, like forced relocations and the diminishment of the public housing sector. The final – and probably also the most discussed – argument is that mixing does not work. Most of the expected positive effects of the social mix rely on the development of bridging social capital but in practice, social interactions between members of different social groups are quite rare.

At the same time, Bolt & Van Kempen also add nuance to the academic debate by stressing that contextual factors play a role in the success of the social mix or the lack thereof. Not all social mix projects have disappointing outcomes. Whether projects succeed depends on a combination of different factors, like the quality of the architecture and the public space, levels of investments in community development, the level of heterogeneity of the residents and the specific spatial configuration of the project.

Magic mix

Pierik (2019) made an inventory of the factors that stimulate social interactions within mixed housing projects in the Netherlands. He looked at a specific type of mixed housing, which is coined as 'magic mix.' A magic mix project is a project in which a combination of vulnerable residents and supportive residents are housed within one housing complex. Examples of vulnerable categories are refugees, homeless people and people with intellectual or psychiatric disabilities. Supportive residents tend to be young households, for whom a magic mix project can be a shortcut to the entry on the housing market as they can bypass the waiting lists for regular social housing. Supportive resident are not the formal caretakers for the vulnerable residents, but they are requested to invest time in organising activities and engaging with vulnerable residents. In some projects, supportive residents get a temporary residence contract, in other projects they get a permanent contract. The projects vary in scale. The largest case study in Pierik's research consisted of 540 dwellings and the smallest had

only 30 dwellings. Bases on 14 in-depth interviews with researchers, architects, urban designers and representatives of housing corporations and care organisations, Pierik (2019) made an inventory of the factors that stimulate social interaction between vulnerable and supportive residents.

Physical factors stimulating social interactions

The following physical factors may help to stimulate social interactions between residents.

- **Size:** In large complexes, there is a higher risk of feelings of unsafety and anonymity. It is better to strive for relatively small complexes (a maximum of 150 units). Larger complexes are feasible if they are split up in smaller compartments.

- **Communal space:** A communal space is crucial for the organisation of activities like having dinner together or playing games. As it should function like a living room, it is crucial to create multiple communal spaces in the larger projects, for example, one living room per storey. A living room for each 10-20 person is seen as optimal.

- **Transition zone:** There should be a smooth transition between private and public space. For instance, a small garden in front of the apartments at the ground level may stimulate interactions with passers-by, while a hard demarcation line may lead to retreatment (e.g. having the curtains closed all day).

- **Entrance:** The entrance should be designed in a way that it is a welcoming place. In this way, fluid encounters or chats between residents are stimulated.

- **Corridors:** Wide corridors not only enhance the feelings of privacy (people pass by at a larger distance) but also make it easier for people to appropriate this space (for instance by placing chairs). At the same time, this stimulates fluid encounters with other residents.

> "A magic mix project is a project in which a combination of vulnerable residents and supportive residents are housed within one housing complex. Examples of vulnerable categories are refugees, homeless people and people with intellectual or psychiatric disabilities."

- **Floor plan:** Locating the kitchen at the side of the corridor enables light interactions with passers-by. (In the kitchen, there is less need of privacy than in – for instance – a sleeping room).

- **Amenities:** Amenities at the ground floor level (like cafes or shops) stimulate interactions between residents within the complex as well as with residents in the rest of the neighbourhood.

Social factors stimulating social interactions

While physical factors are helpful in creating the right conditions for social interactions, other factors are probably more important. For instance, the role of caretaker is crucial. The caretaker is taking care of the management of the building on behalf of the housing association. His role is not only to make sure the complex is maintained well but also to intervene in conflict situations and to help stimulate communal activities. Next to that, much emphasis is placed on the self-management of the residents. To stimulate self-management, residents associations are established and several commissions are formed, focused on – for example – the organisation of communal activities, selection of new residents or maintenance of the communal garden.

Perhaps the most crucial factor in the success of magic mix projects is the selection of supportive residents. A careful screening process is needed to exclude young people who only apply for these projects to find a dwelling as soon as possible. These people are not likely to invest time in communal activities. Although the requirements in the residence contract concerning investment in the community are not watertight in a legal sense, most projects have succeeded in attracting residents that are committed to the public good.

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DIVERCITIES
governing urban diversity

Dr Gideon Bolt
Department of Human Geography and Planning
Faculty of Geosciences
Utrecht University
Tel: +31 30 253 1399
g.s.bolt@uu.nl
https://www.uu.nl/staff/GSBolt/0

REGIONAL DEVELOPMENT IN SWEDEN

THE STORY OF AN INTERNATIONAL DEVELOPMENT LAB

WHEN YOU PASS THROUGH THE DOORS OF THE ALEXANDERSON INSTITUTE IN SWEDEN, IT IS LIKE SETTING FOOT IN AN ADVANCED INTERNATIONAL DEVELOPMENT LAB. IN THIS HIGHER EDUCATION INSTITUTE, NEW AND EXCITING METHODS ARE CREATED TO PROMOTE FUTURE GROWTH, AS WE NOW DISCOVER

The Alexanderson Institute is a part of Centrum För Livslång Lärande (CIl), Municipality Of Varberg, Sweden. So, what is unique about our approach at the Alexanderson Institute? In a word, it's openness. Every window is wide open. We are always looking for the best sources of experience and knowledge, while continuously developing new tools. We mix everyday ingredients of many and varying kinds, and we are happy to let others contribute to the result. We season with untested approaches and new solutions. There is a great deal of fresh thinking in everything we do at the Alexanderson Institute.

But creativity does not automatically lead to success. Instead, development is driven by experimentation, while also letting those around us contribute, become engaged and judge what we do – often receiving a surprise or two in the process.

The important thing is that the results of these efforts provide insight, vitality and value to others. We want everyone who contributes to help ensure the results are passed on. That is how organic development is created.

REVOLUTIONARY YEARS

Ten years have passed since the official opening of the Alexanderson Institute, or AI as we call it.

The concept of "Competitive Knowledge" is central to the Institute's philosophy. Our interpretation is clear: we always start from the conditions and needs of those around us before adding the value and benefit that is demanded. We have pursued this approach in real-life situations – with striking results. Right from the beginning, we had a strong position, enjoying goodwill within the EU-financed projects we participated in. And throughout these years, we have strengthened our position.

Today, we are seen as a potential partner in many of the development programmes that established organisations compete to take part in. The reason for this is largely thanks to the way we successfully deliver value for money.

It is through this funding and the tangible benefits offered by international networks that value is created for us in our region and in the regions we work with. It's about give and take – and building confidence between people.

THE THREE WISE Ms

We are constantly striving to clarify not only our role in the complex interplay of synergies around the development of the region but also how business and public organisations can expect to benefit.

Alexandersoninstitutet

We explain this through our three Ms – mediator, meeting place and a motor for competitive knowledge. Our activities revolve around these concepts. The Alexanderson Institute facilitates the flow of knowledge, experience and competence. We offer an infrastructure for creating meetings and networks, which, in turn, generate new ideas, methods, business and returns. The motor, the third component, is a result of the other two.

A POSITION IN THE VALUE SOCIETY

The Alexanderson Institute is located in the region of Halland, Sweden. This is where we have our roots and where we wish to share our success.

Equally important for the future is being part of the same value region. Today, value solidarity is even more important than physical solidarity – thanks to the rapid growth of digital infrastructure. For the first time in history, groups of individuals, companies and organisations can establish value links in new ways.

Who is to say that a person or company, or even a municipality, derives the greatest benefit from its closest neighbours, when it is just as easy, or even easier, to maintain contact and exchange experience with kindred spirits on the other side of the world?

Thanks to its growing international networks, the Alexanderson Institute has created strong links to a value-based region. Every day, we meet people and organisations who are on the same wavelength as we are – and who want to partner with us in developing the future.

In Halland, we are the leading player in the new international value arenas. We open doors. We give all those in our networks access to these arenas. And this is just the beginning.

A GROWING KNOWLEDGE ORGANISATION

The Alexanderson Institute and Campus Varberg are developing in tandem and have built up unique network-based structures. The Alexanderson Institute is in collaboration with governmental and regional platforms, municipalities, universities and national SME's, and is involved in several key EU projects. Campus Varberg through the university programme and vocational college, in conjunction with other seats of learning, are complemented by key contacts in business and the public sector.

Rebalancing the economy – our time is now

Nigel Wilcock is Executive Director of the Institute of Economic Development and says that when it comes to rebalancing the economy – our time is now

The recent cross-party Treasury Committee inquiry into Regional Imbalances in the UK Economy, which set out to examine the nature of regional imbalances in economic growth which exist in the UK, is a welcome development.

Whilst we wait the outcome of the inquiry a joined-up approach to this issue is truly needed, there is certainly no shortage of evidence out there around the disparities and differences that exists between different areas – north and south, towns and cities and urban and rural.

Analysis from Communities in Charge, a coalition of community leaders and charities, found that the UK's poorest regions could lose hundreds of millions of pounds of funding to London and the South East after Brexit. The comparison of UK government spending on economic development with distribution of European Union (EU) structural funds revealed significant regional differences between the way in which the EU and the UK allocates funding for economic development.

Communities fear that if the UK Shared Prosperity Fund (UKSPF) is distributed in the same way the government allocates current spending on economic affairs, it will unfairly benefit more prosperous areas. Communities in Charge have warned that economic development funding is set to "follow the regional pattern of existing UK programmes and end up increasing regional inequalities rather than reducing them".

We know that a different approach is needed. Our own consultation on the UKSPF, published in April 2019, provided insight on what the new fund could and should look like and how it must operate in order for it to be successful. However, at the time of writing (although admittedly only a week into Boris Johnson's reign as PM), we remain none the wiser on exactly when the government consultation on the design of the fund will take place and how much money will be allocated and how it will be distributed.

These latest warnings are not new. The Cities Outlook 2019 report, published by the Centre for Cities, highlighted the consequence of the government withdrawing almost all domestic economic development funds for the regions ten years ago. The report showed that cuts to all spending areas minus social care, where there has been a need to make up for shortfalls, have been deeper in English cities. Economic development has fallen particularly in urban areas – spending is down 43% compared to 24% elsewhere. This means that social care has taken up a growing share of overall spending, rising from 38% of spending in cities in 2009-10 to 46% in 2017-18. At the start of the period four cities spent more than half of their budgets on social care. By 2017-18 half of all cities did so.

At the same time, the report highlights the importance of cities to the economy. Despite covering just 9% of land, British cities account for 54% of the population, 63% of economic output and 71% of knowledge services jobs. This concentration of the UK economy in specific places occurs because of the benefits that cities provide – namely access to lots of workers and proximity to other businesses. And their role goes beyond direct economic links. Because of their scale, they are able to support a greater number of specialisms and provide a wider range of services, also impacting surrounding areas.

Yet despite their scale, many of the biggest cities punch below their weight. Cities such as Manchester, Birmingham, Liverpool and Sheffield lag the national average on productivity and a range of other indicators, when they should be leading it. Generally, cities have

been hit hardest by austerity. As a whole, there has been an 18% fall in the day-to-day spending by local government in cities between 2009-10 and 2017-18, compared to a 9% fall elsewhere. This meant that British cities – home to 55% of the population – have shouldered 74% of the total cuts to local government's day-to-day spending.

"There is a lot to consider – but our time for rebalancing the economy is now. To ignore the differing roles that different parts of Britain – be they cities, towns or more rural areas – play in the national economy is to misunderstand an important part of how the economy functions."

To quote The Cities Outlook 2019 report directly: "In or out of the EU, for the UK economy to be more prosperous it needs its cities to make a larger contribution than they currently do." We are now seeing on the-ground campaigns for change. For example, across the north of England have reached a critical level, more than 30 local and regional newspapers and media outlets (alongside major political and business leaders) have called on the government to revolutionise the way the region is governed. Papers including the Sheffield Star, Manchester Evening News and Liverpool Echo have demanded "a fundamental shift in decision-making out of London, giving devolved powers and self-determination to people in the north".

At the same time, we need to champion the rural economy. In April, the House of Lords Select Committee on the Rural Economy called on the government to develop a rural strategy and help realise the potential of rural economies. I have previously said that rural communities are likely to face the most serious economic issues of any locations in the UK over the next 20-30 years and the 'Fourth Industrial Revolution' is likely to create an existential threat to many. Priority interventions to avoid catastrophe must include digital connectivity, housing, business hubs, community self-help, mobility clubs and decarbonising heat, but rural economic development urgently needs a longer term strategic approach.

Balanced growth is an issue for all UK residents. Better balance will ensure that public assets are used more

Nigel Wilcock

evenly and efficiently – avoiding issues such as under-utilised schools, hospitals and transport networks in some locations and pressure from overcrowding in others. A balanced economy can also, in the long-term, avoid the payment of subsidies to support under-performing areas and allow improved public finances from greater taxation revenues from across all parts of the UK. Finally, socially and politically, there is surely a need to avoid parts of the country feeling increasingly left behind.

There is a lot to consider – but our time for rebalancing the economy is now. To ignore the differing roles that different parts of Britain – be they cities, towns or more rural areas – play in the national economy is to misunderstand an important part of how the economy functions. ■

Nigel Wilcock
Executive Director
Institute of Economic Development
Tel: +44 (0)1925 730 484
admin@ied.co.uk
http://ied.co.uk/
www.twitter.com/theied

Climate doesn't wait: More ambition and accelerated action needed

Luca Jahier, President of the European Economic and Social Committee, argues that climate doesn't wait but more ambition and accelerated action on it is needed in Europe

July was a clear wake-up call: Much of our planet sweltered in an unprecedented heatwave, as temperatures soared and reached new heights in the hottest month ever recorded globally. Signs of ecological collapse are getting clearer by the day. Parts of the earth might soon be too hot to live in, more people are getting killed in floods, forest fires and heatwaves every year, putting humankind's very survival at risk.

Young people across Europe and the world, led by Swedish 16-year-old climate activist Greta Thunberg, have taken to the streets to demand more and stronger climate and green policies. The call has not gone unheard and the proof lies in the ballot box, as Europeans in many countries have increasingly backed green parties at the last elections. But time is short: We must accelerate reforms.

The EESC has been since a long time at the forefront in pressing for the delivery of the 2030 Agenda. The 2030 Agenda is the strategy through which the European Union (EU) can become the world champion of the sustainable competitiveness that balances economic prosperity, environmental issues and social inclusiveness. As EESC president, I am utterly convinced that the 2030 Agenda is a win/win strategy for the employers, the workers and the civil society.

When EU leaders failed to agree on an EU-wide target to make the EU carbon neutral by 2050 last June, many were disappointed. But the deal is not off the table. Finland, who currently holds the EU presidency, is eager to get it done by the end of the year. The UN is holding a climate summit in September in New York City, which could bring new momentum to the negotiations. At the same time, we have a new European Commission President, Ursula von der Leyen, who has pledged to present a "green deal" for Europe in her first 100 days in office and legislate to achieve "climate neutrality" across the EU by 2050.

Is all this a bit more reassuring? Surely. However, we need to understand that grand policies go hand in hand with micro policies. Everything that contributes to reduce our carbon footprint needs to be thought through, not only at EU level but also at the national, regional and city level.

> "New laws brokered last year, if fully implemented, could help the EU achieve around 45% emissions cuts by 2030. But countries are not on track to reach that objective."

In Europe, 210 mayors from all across the continent recently called for more ambitious emission reduction targets. And other local and regional authorities have declared climate emergencies in their constituencies to raise awareness about the issue.

So far, countries even the one leading the way on climate, like Finland, Sweden or Germany fall short on coming up with concrete measures to achieve ambitious carbon reduction objectives.

In June, the European Commission issued its recommendations on the draft national energy and climate plans (NECPs) submitted by the 28 EU member states to achieve their 2030 objectives and called for "stronger ambition, more policy detail, better-specified investment needs, or more work on social fairness."

The plans are not up to target. For example, renewable energy deployment could fall short by 1.6 percentage points against a 32% target for 2030. Energy efficiency measures risk leaving a gap of 6.2 percentage points versus a 32.5% benchmark.

Luca Jahier

Member states will come up 2% short in sectors like agriculture, ground transport and buildings, which are not covered by the EU's carbon trading system. The current trajectory is heading for 28% cuts rather than the agreed 30%.

At best, the National Energy and Climate Plans (NECPs) could achieve an overall greenhouse gas reduction of 40% compared to 1990 levels, the EU's official target, which is now largely considered outdated since it was agreed in 2014 before the Paris Agreement was signed.

The European Parliament, as well as UN Secretary General Antonio Guterres, have called for that goal to be ratcheted up to 55%, saying that would bring the EU in line with its Paris commitments.

New laws brokered last year, if fully implemented, could help the EU achieve around 45% emissions cuts by 2030. But countries are not on track to reach that objective.

Member states have now six months to raise their national ambition. In the meantime, the EU, which will start negotiations on its multi-annual financial framework (MFF) must follow suit. To launch a genuine Green Deal, as President Von Der Leyen proposed, the EU must give itself the means.

> "In Europe, 210 mayors from all across the continent recently called for more ambitious emission reduction targets. And other local and regional authorities have declared climate emergencies in their constituencies to raise awareness about the issue."

The EESC has made it clear that the Commission's proposal does not seem ambitious enough in that regard. We think that the current 1% ceiling for the EU's expenditure be increased to 1.3% of GNI.

The MFF is not a book-keeping exercise, it is a political act. It is about providing, or not providing, the European Union with the means to deliver its agenda: a sustainable future for 500 million citizens. We need more political acts as climate doesn't wait. ■

Luca Jahier
President
European Economic and Social Committee
Tel: +32 (0)2 546 90 11
www.eesc.europa.eu
www.twitter.com/EU_EESC

Bridging the gap between research institutions and commercial multipliers of climate services

Julius Pröll from the Climate Service Center Germany turns our attention to the importance of bridging the gap between research institutions and commercial multipliers of climate services

Global climate change has very different regional impacts that are already being felt today (IPCC 2019, IPCC 2018). For decision-makers in politics, administration and business, this means an increasing need for specific information to adapt adequately to the current and future impacts of climate change. The Climate Service Center Germany (GERICS) works to address these needs by developing user-oriented information and consulting services, verifying them in practice and striving for their operational use by companies, such as consultancies or engineering offices.

To further promote operational climate services and scale-up their societal use, GERICS has analysed in a project called "Bridging the Gap", how climate services can be transferred from research institutions to commercial providers. The process behind this transfer is commonly referred to as technology transfer (Bräutigam & Gerybadze 2011). Successful technology transfer enables research institutions to increase the societal influence of their own research and to actively transfer the developed prototypes to operational providers and, thus, multiply them. There is consensus in the political environment that the potential of technology transfer in non-university research is not yet sufficiently exploited (Otto et al. 2015). Depending on the service or product, specific barriers and, thus, new challenges can arise and this is particularly true in a field as youthful as climate services, where experience relating to technology transfer is limited.

GERICS, therefore, extended the commonly used and established technology transfer process and its findings to the area of climate services to identify specific barriers related to the transfer of climate services and possible solutions to overcome them. Since several technology transfer procedures exist but none for climate services, in particular, a new procedure has been developed (see figure 1). Parts of the procedure can be carried out simultaneously (e.g. the evaluation of the commercial potential and the analysis of the intellectual property framework). It can be described in the following five steps:

- Internal product analysis with product developers (1).
- Evaluation of the commercial potential of the climate service (2).
- Analysis of the intellectual property framework conditions (3).
- Analysis of the technical framework and potential adjustments (4).
- Establishing a commercial exploitation strategy for the climate service (5).

As part of the project Bridging the Gap, various methods, such as the "Business Model Canvas", "Workshops" and "Qualitative Interviews" have been applied to identify barriers within the climate service technology procedure. By doing so, barriers were revealed in the areas of commercial potential, intellectual property (IP) and technical framework. For example, parts of the commercial potential of climate services e.g. willingness to pay, are not described in known literature and, therefore, identified as a barrier to climate service technology transfer. To research the commercial potential, interviews were conducted with companies in Germany. The results showed that some companies consider the topic of adaptation to climate change as relevant to them and that they are willing to pay for climate service products. Hence, the commercial potential of climate service products, in general, exists.

Also, further identified barriers, such as an unawareness of potential multipliers (companies, who sell a licensed climate service product) of climate services, should be identified and addressed by scientific institutions

Figure 1: Simplified representation of Climate Service technology transfer. Own figure, based on Fotolia/seamuss

Intellectual property barriers	Solution options
The licenses used (e.g. climate data) in the product do not permit commercial use.	If commercial use is prohibited: • Other licenses or products have to be used. If this is not possible: reach out to the licensor. • Ask for written permission. • Conduct license negotiations with licensors regarding the commercial use of their licenses.

Figure 2: Excerpt of the climate service technology barriers and solution catalogue

early on during the prototype development process. Moreover, not only should the requirements of the end-user be taken into account by research institutions, but also those of the potential multiplier, to facilitate an increased societal relevant climate service technology transfer in the future. Overall, for future climate service technology transfer, the identified barriers can probably be overcome when taken into account early on during development and are coordinated by a technology transfer manager. In order to support this, a solution catalogue, containing barriers and their solutions has been developed (see an excerpt in figure 2). Furthermore, strategic support for technology transfer from the management must exist and an entrepreneurship culture should be promoted. By doing so, the societal impact of climate services can be increased by research institutions.

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GERICS
Climate Service Center Germany
An institution of Helmholtz-Zentrum Geesthacht

Julius Pröll
Climate Service Center Germany (GERICS)
Tel: +49 (0)40 226 338 0
julius.proell@hzg.de
www.climate-service-center.de

Fighting the war against climate change

Laszlo Giricz, Founder and CEO, discusses the work underway at Poseidon to provide solutions for greenhouse gas emissions during the current battle against the climate change emergency

About 66 million years ago, a group of senior dinosaurs pondered whether the cost for a global asteroid defense system would be justified. After thorough consideration, it was decided that it was not worth the money. And even though many of the younger dinosaurs kept on telling their parents that they were really scared of the shooting stars they occasionally saw, the older and wiser dinosaurs assured them that shooting stars were beautiful and not something to be scared about.

Joking aside, we of course know that dinosaurs did not have the capacity to understand this risk, let alone prepare a mitigation. That is why it is even more surprising that the apparently most intelligent species that ever walked on this planet does not use its knowledge, intelligence, and combined resources to address the greatest threat to our existence. Let us look at the facts.

There is an over 90% consensus amongst climate scientist, globally, that we are heading towards a climate catastrophe. Scientists that say that this is nonsense turn out to be experts in fields that have little to do with the climate of our planet. Changing weather patterns have already negatively impacted global agriculture and recent extreme weather events clearly pushed humanity to its limits. 40+ degrees Celsius might be nothing more than a warm day in the Middle East, though across Europe, where houses were not built for such temperatures and where humidity levels are significantly higher, the situation had been life-threatening.

And not just for humans. Bees are starving because they are coming out of their winter sleep earlier than they should and plants are dying because temperatures and rainfall are not as they used to be. The severity of the situation seems so overwhelming that it is hard to imagine there is still a way to resolve it. When we look at the

wide-spread political and social issues that around four million wartime refugees from Syria have caused across Europe, the predicted hundreds of millions of climate refugees globally seem like an unsolvable challenge. It is clear that understanding this threat is not enough and unfortunately, global action is still far from what it needs to be.

In the year 2015, 197 countries signed the Paris Agreement and agreed that the temperature rise compared to pre-industrial levels had to remain below 1.5 degrees Celsius. It was an unprecedented unanimous agreement across all parties of the United Nations that climate change is a severe threat to human existence. Unfortunately, according to Climate Action Tracker, less than 4% of those countries have done enough to keep temperature rise below 2 degrees.

Luckily, there is a growing number of eco warriors who understand that the time to act is now. They dedicate their lives towards making this world a better place for all of humanity and they use all their resources to achieve this goal. One of these eco warriors is Laszlo Giricz, the founder of Poseidon. While living in Singapore, he was exposed to the yearly haze, when smoke from largely illegal deforestation in Indonesia results in a significant reduction of visibility and air quality across Southeast Asia. He knew something had to be done, and in 2017, Poseidon was born.

Poseidon at its core is the dream that a future where every consumption is turned into positive action truly is possible. Everything, really everything that is purchased has an impact on our environment. Whether it is a product or a service, consumption impacts the people and the ecosystems around us. When that impact is negative, both long-term and short-term solutions are required. In the long-term, solutions are required that reduce or ideally even eliminate negative effects. In the short-term, unavoidable negative impacts need to be addressed with positive action.

A utopian future where all transportation will be environmentally friendly, perhaps using electric engines or hydrogen-powered, seems possible. Being realistic, it is clear that this will take decades and not just a few years. What can be done until then? What if it would be possible to address all the negative impacts today by doing good somewhere else? What if releasing a certain amount of greenhouse gas emissions into the atmosphere could be addressed by ensuring more than that amount is protected somewhere else?

Poseidon has successfully been providing a solution for greenhouse gas emissions to corporations like the ice-cream brand Ben & Jerry's, the supercar manufacturer BAC, the shoe brand Vivobarefoot, and even government entities like the council of the iconic city of Liverpool.

Since May 2018, Poseidon connected real-word positive impact, protecting the rainforest of Cordillera Azul in the Peruvian Amazon, with the emissions created by everything from shoes to city councils. Of course, the ultimate solution has to be the significant reduction of greenhouse gas emissions. Until that day, Poseidon's platform bridges the gap.

To give a more detailed look at the solution, first, the climate impact is qualified and quantified, as for example the greenhouse gas emissions of the city council of Liverpool through Carbon Trust. Then, more than the negative impact, more than the greenhouse gas emissions that the city council is responsible for, is protected by saving an appropriate area of rainforest from deforestation. By having a greater positive than negative impact, the activities of Liverpool City Council were turned into climate action. And to ensure traceability and transparency, Poseidon is using the environmentally-friendly Stellar blockchain technology to provide verifiable proof of positive action. It is a real solution using cutting-edge technology that is available today.

The sheer size of environmental and social challenges globally is overwhelming. A few dozen years ago, there would have probably been very little hope. Today, with the revolutionary solutions Poseidon and other eco warriors are creating, the tools to avert a climate catastrophe are available. It is still possible to change course and rescue an environment that is able to support life on Earth. Poseidon's platform can empower everyone to be part of the solution and hopefully, humans will not end up like dinosaurs.

POSEIDON

Laszlo Giricz
Founder and CEO
Poseidon
info@poseidon.eco
www.poseidon.eco
www.twitter.com/Poseidon_NGO

Climate change: Modifying our views on environmental risks

Alberto Mantovani and Francesca Baldi - Istituto Superiore di Sanità in Rome, Italy, explain to us how the global issue of climate change is modifying our views on risks to the environment with comment on the main effects of chlorinated pesticides

Our world is facing climate change (some people call them "climatic crisis") that are modifying our views on environmental risks. For instance, climate change is increasing the levels of exposure of aquatic organisms to UV radiation by reducing the thickness and duration of snow and ice cover, melting of glaciers and permafrost and increases in heavy precipitation. While UV radiation directly damages the health of environmental organisms, less recognised effects include the formation of micro-plastic pollutants, with bioaccumulation in food chains and increased toxicity of contaminants, such as pesticides and polycyclic aromatic hydrocarbons.

"Legacy" pollutants are manmade chemicals that can persist in the environment after banning and end of discharging. Top concern legacy pollutants have been produced at great amounts, bioaccumulate in food chains and show toxicological properties that can affect the current, as well as the next generations, such as endocrine disruption. The chlorinated pesticides identified as Persistent Organic Pollutants (POPs) under the Stockholm Convention share such features (2001 and successive updates): the most well-known is DDT, but the long list includes dieldrin, endosulfan, hexachlorobenzene, lindane and hexachlorocycloexanes and several others. Due to their lipophylicity, measuring such chemicals in adipose tissues and eggs of animals can indicate anthropogenic influences in remote ecosystems, e.g., the Arctic.

> "In an unlucky scenario, the widespread and increasing presence of pesticides residues in important and vulnerable food sources (e.g., seafood, milk from ruminants on pasture) might pose unpleasant choices to risk managers, such as salvaging food availability while weakening food safety standards."

Despite their persistence, chlorinated pesticides are not eternal; after the ban, their presence in the environments and food chains have shown slow but consistent declining trends over decades, as stated, e.g., by their assessments as contaminants in feeds by the European Food Safety Authority. Moreover, a portion of pollutants is trapped (or "scavenged") within some environmental comparts, such as permafrost.

Long-range atmospheric transport is a major pathway for delivering POPs to the water and terrestrial environments; atmospheric patterns can be altered and possibly increased, by global warming, which calls for updates of the models to predict and monitor POPs travelling. Snow and permafrost melting will provide an output of newly bioavailable molecules: deposition into sediments of rivers and seas will lead to uptake by food webs, including those relevant to our diet.

As melting accelerates under climate warming, the release of trapped chemicals may also increase, likely following a seasonal pattern, with possible pulses: the seasonal patterns of melting processes may also alter the exchange rates between air and seawater. Warming and continued decline in sea ice are also likely to result in shifts in food web structure, which in their turn, would modulate the deposition of pollutants in seafood, mainly large fatty fishes but also sediment-dwelling organisms such as shellfish. The direction and extent of the above-mentioned modifications are currently difficult to assess and more data on a range of trophic levels are needed to estimate the possible increased exposure of human diet, either globally and for specific populations, e.g., communities from the Arctic and sub-Arctic regions.

The potential for exposure is not the same for all chlorinated pesticides. For instance, DDT metabolites and hexachlorobenzene feature among the most persistent and bioaccumulating substances of the group; lindane is more toxic but definitely less persistent than its manufacturing by-product beta-hexachlorocycloexane.

One might say that the release of banned pesticides is the least of concerns related to climate change.

However, let's consider the implications: from a social and economic standpoint, an increased presence in food and feedstuffs of toxic substances, for which legal limits exist, is a source of national and international alerts, calling for increased controls of raw materials by enterprises and public bodies, disrupting global trade and weakening the confidence of consumers. In an unlucky scenario, the widespread and increasing presence of pesticides residues in important and vulnerable food sources (e.g., seafood, milk from ruminants on pasture) might pose unpleasant choices to risk managers, such as salvaging food availability while weakening food safety standards. What would be the actual health risks? Significant uncertainties do exist. The current tolerable limits in feeds and foods for chlorinated pesticides are based on outdated data sets: after the ban, only limited research has been carried in order to update health-based guidance values. Yet, according to available data from independent research, the main effects of chlorinated pesticides include disruption of steroid and thyroid hormonal axes, altered development of neurobehavioral and/or immune functions, altered metabolism in liver and adipose tissue. Such effects are of top concern for the international risk assessment community and since the last decade, a major effort is ongoing to update toxicological testing to characterise such effects more properly.

In practice, we currently have a fairly accurate view of how many residues of chlorinated insecticides are in foods and feeds and also increasing data on human biomonitoring; conversely, we have many uncertainties to assess whether such exposure levels might pose a risk to the general population or vulnerable groups (unborn children, toddlers). Last, but not least, the mixture issue must be considered. These pollutants often occur together, in the same matrices (e.g., lipid-rich foods); while the individual levels are usually very low, many substances share toxicological modes of action and effects: for instance, DDT, its metabolite p.p. DDE and the persistent by-product of lindane, beta-hexachlorocyclohexane, all may exert estrogen-like actions. The available evidence call for a new risk assessment, where individual substances are grouped based on their toxicological properties. The release of currently trapped persistent pollutants may, therefore, be a real issue.

"While UV radiation directly damages the health of environmental organisms, less recognised effects include the formation of micro-plastic pollutants, with bioaccumulation in food chains and increased toxicity of contaminants, such as pesticides and polycyclic aromatic hydrocarbons."

So what do we do? The global action against emissions that increase climate change must go on and for now, some specific actions can be envisaged: targeted monitoring of ecosystems for a timely identification of trends; updating of guidance values in environments, foods and feeds with the support of new research and modelling; considering the mixture issue for risk assessment; targeted monitoring of the most vulnerable food chain to prevent health risks. It may be useful to set "alert" (calling for attention and investigation in depth) and "action" (calling for risk mitigation) levels for the most prevalent chlorinated pesticides (including metabolites and by-products): this could facilitate the (sometimes-uneasy) job of risk managers.

In the area of Anthropocene, the assessment of the impact of environmental changes must include the assessment of their effects on presence, persistence, kinetics and toxicity of chemicals spread by human activities into the environment. The assessment has to be pursued with a "One Health" approach, linking ecosystems, feed and food production chains and human health.

Alberto Mantovani
Research Director
alberto.mantovani@iss.it

Francesca Baldi
francesca.baldi@iss.it E
Istituto Superiore di Sanità – Roma, Italy
Tel: +39 06 4990 2815
http://old.iss.it/inte/index.php?lang=2

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Transitioning to a green economy: Is carbon offsetting the answer?

When it comes to transitioning to a green economy and the extent to which carbon offsetting is the answer, William Richardson, Founder and Managing Director of Green Element provides his thoughts

According to studies performed by the Economist Intelligence Unit, a rise in global temperatures of six degrees (which is the worst-case scenario) would inflict $43 trillion of losses on investment portfolios. This is around 30% of the entire stock of manageable assets.

Consequently, a transition to an inclusive green economy is vital. In 2008 the UN created the Green Economy Initiative, aimed at encouraging governments to invest in protecting our environment. They defined the 'green economy as one that results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities.'

In order to achieve a green economy, the UN encouraged a focus on; 'circularity, collaboration, solidarity, resilience, opportunity and interdependence.'

During the past decade, there has been a focus on the circularity element. The concept of moving away from the linear economy to the circular economy has been prevalent. Traditionally, our economic model was based on the linear approach. In other words; take, make and dispose. We would recklessly extract precious materials from the ground, make them into products (which had a short life span) and then we would landfill the items when we no longer wanted them. These used items were claimed to be worthless.

However, we know this is far from the truth. Items made from precious materials, extracted from the ground are finite. They have a lot of value.

This is where the circular economy comes in. The idea that we must consider the end of life process of items being manufactured. The circular economy is based on a model which instead of land-filling products saves them.

Not only is less waste better for the environment but it is also better for our economy. Businesses that recycle save costs on extraction. For example, recycling one ton of iPhones will yield 300 times more gold than extracting one ton of gold ore.

Other aspects of the green economy involve investing in environmental projects. For example, carbon offsetting enables companies or governments to buy carbon credits. This means that carbon emitted can be balanced out by carbon credits purchased. In this way, a company or country can be deemed 'carbon neutral,' without having to actually stop emitting carbon dioxide.

"According to studies performed by the Economist Intelligence Unit, a rise in global temperatures of six degrees (which is the worst-case scenario) would inflict $43 trillion of losses on investment portfolios. This is around 30% of the entire stock of manageable assets."

In theory, a company can emit as many tonnes of carbon dioxide as they like but if they buy back the number of tonnes emitted, they can write on their website they are carbon neutral. Transitioning to a low carbon economy in this way is not necessarily the answer.

In order to avoid financial and environmental disaster, we need to ensure that the green economy is executed efficiently. ■

https://compareyourfootprint.com

William Richardson
Founder and Managing Director
Green Element
Tel: +44 (0)207 0960 054
info@greenelement.co.uk
www.greenelement.co.uk
www.twitter.com/Green_Element

A Green New Deal for Europe

Here, Raimund Bleischwitz from University College London, Bartlett School of Environment, Energy and Resources (UCL BSEER), proposes a Green New Deal for Europe that is able to deliver prosperity to the people and worldwide

Many voices say there is crisis all over – and mistrust in politicians and politics. But is it all that bad? The new European Commission sends a strong signal of collaboration and bold ambitions. It is good to see three competitors for the presidency – Ursula von der Leyen, Frans Timmermans, and Margarethe Vestager – now rallying behind one banner. Most European citizens want the Union to become a beacon of sustainability, a place that respects the rights and livelihoods of all its citizens and the environment. Smart and comprehensive strategies are needed. We propose a Green New Deal as both a new mission and a programme that brings jobs and quality of life to the people. The internal and external conditions to deliver are challenging; but we believe there is actually now a spirit and a momentum that could overcome constraints and unleash opportunities.

What is Green in a New Deal

Summer heatwaves, storms and flooding indicate climate change as a common threat. Hardly anyone will be able to escape hothouse conditions and mitigate risks. Thus, a net zero carbon target is a 'must have' for the future of Europe. But there's more to it – for change to happen, one needs positive visions and trigger collective aspirations. Ensuring access to modern energy services, affordable housing, smart mobility, clean water and healthy food is good for people, profits and the planet.

To achieve such goals, companies and countries ought to decouple their current key performance indicators such as 'Earnings before interest, tax, depreciation and amortization (EBITDA)' and GDP from natural resource throughput. Measuring carbon footprints and other footprints for water, land and materials is well established and improves resilience of supply chains.

We propose a European reduction of those footprints in line with the Paris Agreement and necessary pollution

abatement. Doing so requires close coordination among several government ministries, local authorities and industry, including buildings and construction, energy, agriculture, and transport. The vision would be a circular economy, one that is restorative by design and maintains both private and public values in line with planetary boundaries and the SDGs.

"Most European citizens want the Union to become a beacon of sustainability, a place that respects the rights and livelihoods of all its citizens and the environment. Smart and comprehensive strategies are needed."

Leaving no-one behind

Surely, deep transformations are required. As experience with earlier transitions in Central and Eastern Europe and many modernisation efforts reveals, the risk of people feeling left behind should be minimised. Existing inequalities hinder human capabilities to flourish, be it for reasons of discrimination, or power dynamics, poor design of change programmes, or imbalanced financing. Why should poor people pay taxes to support photovoltaic installed on houses for the rich?

We propose a deliberately asymmetric deal: put the lower half of the people first. Key workers in health, mobility, education and security deserve to be treated with respect and receive favourable conditions. Urban transformations and rural strategies require participatory planning to identify and address the needs of the poor and the lower half of societies. People can be involved via concepts of 'citizen science' and, indeed, via social media. If done well, the future digital revolution holds further promises for participation and leaving no-one behind. It will be of utmost importance to include those criteria in revised European regional policies and investments.

Subsidiarity and diversity

It's been cheap in the past to blame 'Brussels' – and not entirely without reason. Complementing Ann Pettifor's proposals on macro-economy, a Green New Deal must come with a bottom-up dynamic, with more polycentric governance, and creativity through experimentation and smart assessments. Business roundtables in regions that involve a range of stakeholders do exist. The EU project 'Recreate' has developed Evidence-based narratives (EBNs) in areas such as Climate Information Services; Nature-based Solutions; Systemic Eco-innovation to Realise a Circular Economy; Sustainable Urban Material Management; Sustainable Urban Infrastructure Systems; Sustainable Urban Adaptation and Resilience that await upscaling and horizontal dissemination across European regions. The data revolution will help to connect people with smart business and governments.

Smart enablers – incentives and three programmes

Economic incentives are needed, both to enable more human productive activities and to end unproductive waste of resources. A smart combination of carbon emissions trading and carbon taxes are a good way forward, in order to focus on key industries and reach out to more dispersed emissions. For a more holistic green new deal, we also propose a moderate tax on construction materials that could boost markets for secondary materials and also help to safeguard access to mineral deposits of public importance.

All this can and should be done in ways that benefit the people. We propose three large programmes for a green new deal:

- Sustainable and inclusive housing, with renovation towards net zero carbon and new models of sharing;
- Smart mobility, with investments in public transportation and high-speed rail and lowering total costs of access, perhaps via a European smart card;
- Healthy food, with regional and sustainable supply, social kitchen, and food waste reduction.

Europe wouldn't walk alone

China, Canada, New Zealand and others are on their way too; a Green New Deal is also a huge debate in the USA – perhaps for a future President, or indeed for numerous states. Whatever happens in the UK and its delicate relationship with the EU: The parliament is committed to net zero carbon, and a new wave of industrial policy with a strong emphasis on green growth and a circular economy is on the way, especially in Scotland. In line, we propose international alliances to learn and scale up solutions. The Chinese Belt and Road Initiative starts to connect Asia and Europe and other parts of the world. A Green New Deal could help creating clean value chains and good regional and international neighbourhoods.

Prof Dr Raimund Bleischwitz
The Bartlett School of Environment
Energy & Resources (BSEER)
Tel: +44 (0)20 3108 9207
r.bleischwitz@ucl.ac.uk
https://www.ucl.ac.uk/bartlett/bartlett-school-environment-energy-and-resources

Global Fellow
Smart Prosperity Institute Canada

Learning about earthquakes in Taiwan

Here, we learn about earthquakes in Taiwan, including the causes of them, the benefits of the Earthquake Early Warning System and the real-time seismic network in the country

The Central Weather Bureau (CWB) in Taiwan researches seismology, meteorology and provides earthquake reports. CWB also reports on sea conditions and makes astronomical observations. [1]

In a previous Open Access Government article from Deputy Director of the Seismological Center Central Weather Bureau (CWB) in Taiwan, we find out how the country's quick earthquake alert system provides notification when it comes to ensuring disaster risk reduction.

"Several hazard earthquakes have occurred during our history. The most famous one was the 1999 Chi-Chi earthquake with Richter magnitude 7.3 in the middle of Taiwan, which killed more than 2,000 and caused mass building damage as well. The threat of an earthquake is, therefore, a serious issue today in Taiwan."

Earthquake Early Warning System (EEW)

In the same article, we also find out that the CWB developed the Earthquake Early Warning System (EEW) to detect significant earthquakes quickly. This means that a warning can be issued about 10-15 seconds after the earthquake occurs. Alerts can be issues around 60 km away from the epicentre and as such, give seconds to 10s of seconds warning prior to the destructive shaking occurring. Nai-Chi Hsiao, Deputy Director of the Seismological Center Central Weather Bureau (CWB) explains more about the EEQ during the last five years, in his own words.

"Since 2014, CWB has provided the EEW warning directly to all the public schools, hazard-rescue agencies and other government departments in Taiwan. Since 2016, CWB has issued EEW warnings through the Public Warning System (PWS) to wireless devices of the general public. The PWS was developed and constructed by the government and communication Corp., which is based on the Cell Broadcast Service (CBS) on the 4G network. This means that all the people in a high-risk area can receive an EEW warning at the same time! CWB also collaborates with TV companies to deliver instant live pop-up messages during the transmission of programmes." [2]

The causes of earthquakes

Perhaps it is worth taking a step back now to briefly look at precisely what the causes of earthquakes are. According to the CWB, earthquakes can either be man-made, or they occur naturally. Generally speaking, we tend to experience naturally occurring earthquakes which can be divided into these areas:

- Tectonic earthquakes;
- Volcanic earthquakes and;
- Impacting earthquakes (like those caused by the impact of meteorites).

Among all these causes, earthquakes for the main part produced by crustal deformation (tectonic earthquakes), caused by plate movement, according to the CWB. On the CWB's website, we find out more about the science behind earthquakes.

"Rock layers are stressed by pressures in the Earth. When the stress is stronger than the strength that the rock layer can withstand, the rock layer will move outward (dislocation). Such dislocations release a great deal of energy, producing elastic waves called seismic waves. When seismic waves reach the surface of the Earth, they cause shaking, also known as (an) earthquake."

The real-time seismic network in Taiwan

Another important area the CWB highlights on their website concerns the establishment of the real-time Central Weather Bureau Seismic Network (CWBSN) in 1994. We know that observation stations distributed over Taiwan as well as in Kinmen, Lanyu, Penghu and Pengjiayu are part of this network. As part of this network, instruments are installed in every real-time monitoring stations which have a three-component (vertical, north-south, and east-west) short-period seismograph. We read more about this fascinating aspect of CWB's on their website, which is extracted below.

"The ground motion signals recorded at these stations are digitally transmitted to the Central Weather Bureau by leased line, and are stored for real-time processing, analysing, and archiving. If the earthquake is felt, the operating personnel will immediately release an earthquake announcement. All real-time signals are displayed in the analogue recorder at the centre, and it is convenient for the staff to check whether or not the earthquake information automatically determined by the real-time processing is correct. The digital data will be filed manually to form a data bank, which will be advantageous for future enquires."

Closing remarks

While earthquakes are worthy of many more articles, we can gain encouragement from the fact that through means of the mass media, convenient telecommunication equipment and the Internet, the general public is alerted about earthquake information as soon as possible. [3] ■

To find out more about earthquakes in Taiwan, I can highly recommend you spend time browsing through frequently asked questions on the topic, here.

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Open Access Government
editorial@openaccessgovernment.org
www.openaccessgovernment.org
www.twitter.com/OpenAccessGov

Oxygen: The challenge for Life

Professor Friedemann Freund, SETI Institute/NASA Ames Research Center,
provides an insight article into the complexities of oxygen

We breathe oxygen, O_2. We use it to power the molecular engines in our bodies that keep us up and running. As part of this process O_2 molecules are broken up. Electrons are taken from the carbon and hydrogen in organic compounds. They are transferred onto oxygen atoms that change their valence from zero to minus two, forming carbon dioxide and water. Simplifying the organic matter as $-CH_2-$ we can describe this process by writing:

$$-CH_2- + 1½\ O_2 \Rightarrow CO_2 + H_2O$$

However, biologists and the medical community have long known that there are intermediate stages with oxygen becoming indiscriminately aggressive in its chemical and biochemical reactivity. The reason is simple: Nature tends to transfer single electrons from one molecule to the next or from one atom to the next – never two at a time. This means that, when oxygen atoms participate in chemical reactions in our bodies, they pass through the O^- stage, a radical. O^- can create havoc in living cells. They have earned the moniker "Reactive Oxygen Species" or ROS for short.

Reactive Oxygen Species (ROS) and response of antioxidants in Biology

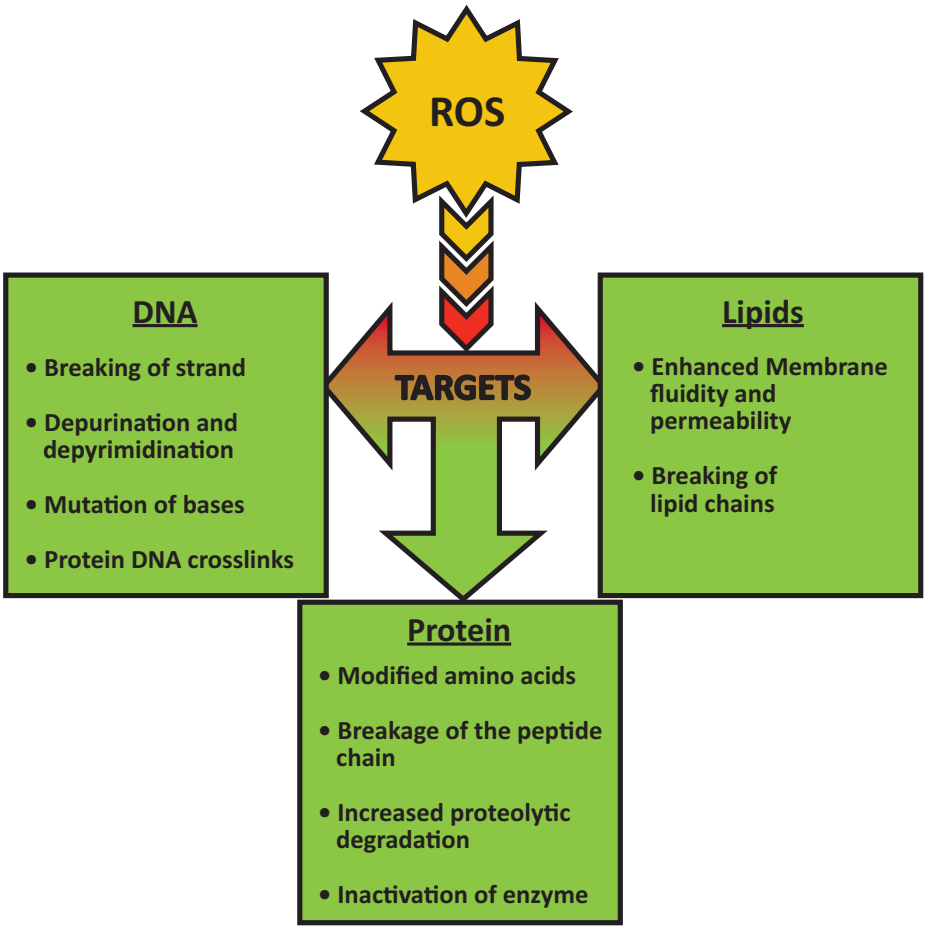

Figure from: Reactive Oxygen Species (ROS) and response of antioxidants as ROS-scavengers during environmental stress in plants. Kausik Das, Aryadeep Roychoudhury. Published in Front. Environ. Sci. 2014. DOI:10.3389/fenvs.2014.00053

To counteract the detrimental effects of ROS Life relies on enzymes such as superoxide dismutase (SOD) and catalase. They contain iron that can switch back and forth between divalent (Fe^{2+}) and trivalent (Fe^{3+}), helping to render ROS less harmful.

There is a widespread belief within the biochemical and medical communities that ROS first appeared in Earth's history after Life "invented" oxygenic photosynthesis to produce O_2. The underlying reasoning has a logic ring: ROS are a byproduct of biochemical reactions in oxygen-breathing organisms. However, the idea that the appearance of ROS is tied to the advent of oxygenic photosynthesis stands in stark contrast to the obser-

vation that the oldest single cell organisms produce enzymes such as SOD and catalase.

These microorganisms live in strictly anaerobic environments and must have done so ever since they appeared on Earth. The question therefore arises: Why did early microorganisms, whose origin predates oxygenic photosynthesis by at least a billion years, produce SOD and similar antioxidant enzymes, if there were no ROS-like oxidants around in their environments?

Could it be that the geological environment produces ROS-like oxidants and has done so since the beginning of Life?

According to textbook knowledge the answer is "no". Rocks in Earth's crust consist of minerals, predominantly silicates, in which oxygen always occurs in the 2- valence state. This concurs with the fact that the Earth beneath our feet retains the memory of its origin as a planet accreting in the highly reducing, hydrogen-dominated solar disk some 4.5 billion years ago. Because the 2- valence state of oxygen is so prevalent, the idea became firmly rooted in the minds of most geoscientists that oxygen in the geological environment is always O^{2-}.

However, there is a process, thermodynamically fully certified, by which oxygen in the valence state 1- is introduced into rocks in a sneaky way. It begins with the crystallization of minerals from magmas that are always laden with fluid phase components, often mostly water, H_2O.

Thermodynamics mandates that, whenever a mineral crystallizes in an H_2O-laden environment, small but non-zero quantities of H_2O will enter the crystalline matrix in the form of hydroxyls, typically O_3Si-OH. In other words, hydroxyls become "impurities", even in minerals that have no place for them in their crystal structure.

Thermodynamics further mandates that, upon cooling, impurity concentrations must decease. This can only be done by hydroxyls diffusing towards the grain boundaries. At the same time diffusion slows down. When diffusion comes to a halt, typically around 500°C, a new reaction takes place that mainstream geoscience has failed to notice: Pairs of hydroxyls undergo a redox conversion and turn into peroxy plus molecular hydrogen:

$$O_3Si\text{-}OH\ HO\text{-}SiO_3 \Leftrightarrow O_3Si\text{-}OO\text{-}SiO_3 + H_2$$

Redox conversions are common in chemistry, ratcheting up the valence of one and down the valence of the other. In the case considered here, hydroxyl oxygens change from 2- to 1-, while hydroxyl protons change from 1+ to 0. The two O^- form a peroxy bond. As long as they are held together, these O^- are chemically inactive. This changes when the O^-–O^- bond breaks.

To understand this step requires a bit of semiconductor physics. The reason is that, when the O^-–O^- bond breaks, electronic charge carriers are generated, electrons e' and holes h•, similar to the electrons and holes in transistors that run our electronics. In minerals and rocks, the e' and h• behave differently than in archetypical semiconductors: the e' get stuck in the broken peroxy bonds, while the h• have the remarkable ability to leave the sites, where they were born. They can spread into the surrounding rocks, traveling far afield, easily tens of kilometres and more.

Why is this important? Because those h• are defect electrons in the matrix of O^{2-}, chemically O^-. They are ROS – Reactive Oxygen Species. They loom everywhere in the geological environment and have done so since the Earth formed as a rocky planet some 4.5 billion years ago. Therefore, when Life appeared on Earth, the first organisms already had to content with peroxy and ROS. This is why they needed enzymes and why SOD and catalase are found in the genetically oldest lifeforms on Earth dating back at least a billion years before the advent of oxygenic photosynthesis. They needed antioxidant enzymes to survive in an early Earth environment that contained peroxy and could unleash viciously oxidizing ROS.

Friedemann Freund
Professor
SETI Institute/NASA Ames Research Center
Tel: +1 650 279 8478
friedemann.t.freund@nasa.gov

Earthquake Early Warning System: What is next for this technology?

NCREE (National Center for Research on Earthquake Engineering) explain how they have developed an Earthquake Early Warning System which can estimate the oncoming waves

NCREE have developed an on-site Earthquake Early Warning System (On-site EEWS), which can detect the first coming P-wave of an earthquake and estimate the strength (Peak Ground Acceleration, PGA) of a following strong wave in 1-3 seconds. An On-site Earthquake Early Warning System composed of the sensing (seismic sensors), processing (PGA estimation of the following S-wave) and Action (warning people, relay control to mitigate the seismic loss) as shown in Figure 1.

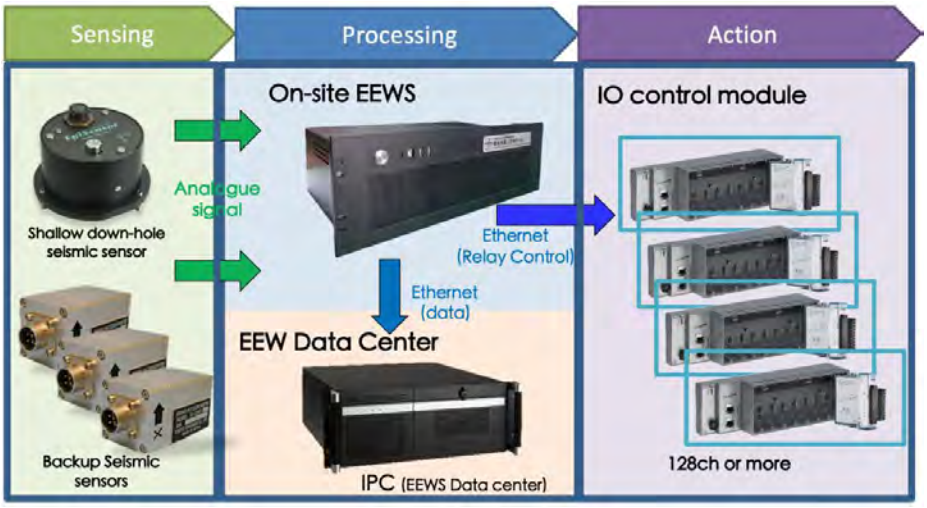

Figure 1: the three components of on-site EEWS Click to enlarge

Multiple seismic sensors are applied in various positions for a double-check to mitigate false alarm. The processing unit will collect the first-three seconds of P-wave (the blue area as shown in Figure 2) and provide estimate PGA for warning immediately. After this, the peak ground acceleration arrives, and the time difference between estimated PGA and real PGA is called the warning time- essentially how much time we can provide in advance. In the case of figure 2, the epicentre distance was 38km, where inside the so-called EEWS blind zone, NCREE's on-site EEWS could still provide 5.34s. With the epicentre distance increasing to 100km, the warning time can increase to ~15s. NCREE have more than 300,000 earthquake time histories in Taiwan.

Through this seismic database and the AI tech (NN and SVM), the EEWS model for Taiwan can be accurately made. Before 2012, numerical and shake table test validations for the EEWS model had been done. From 2013, more and more on-site EEWS's had been installed, validated and refined in field. As of 2019, more than 100 on-site EEWS have been installed by NCREE and serve for 3500 schools, 20 fire departments, 15 office building, 6 semiconductor plants and a high-speed railway. The annual estimation accuracy was made for several years as shown in Figure 3. The estimated and measured PGA data were always in agreement.

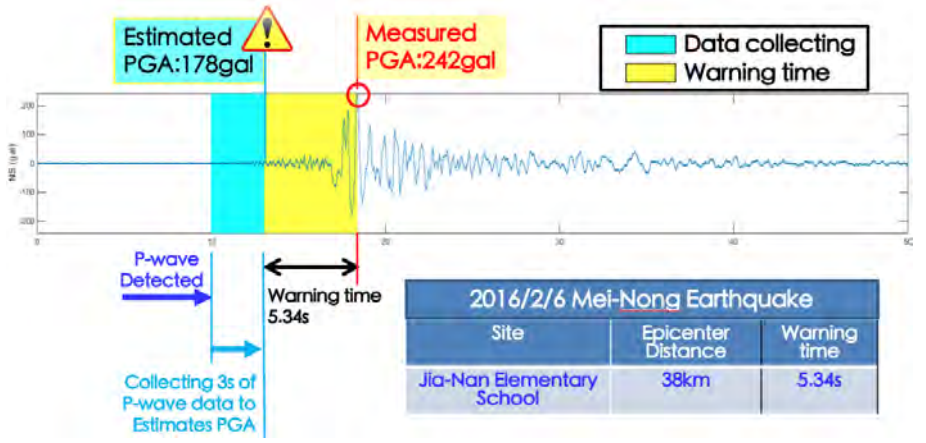

Figure 2: Typical working time history of the on-site EEWS Click to enlarge

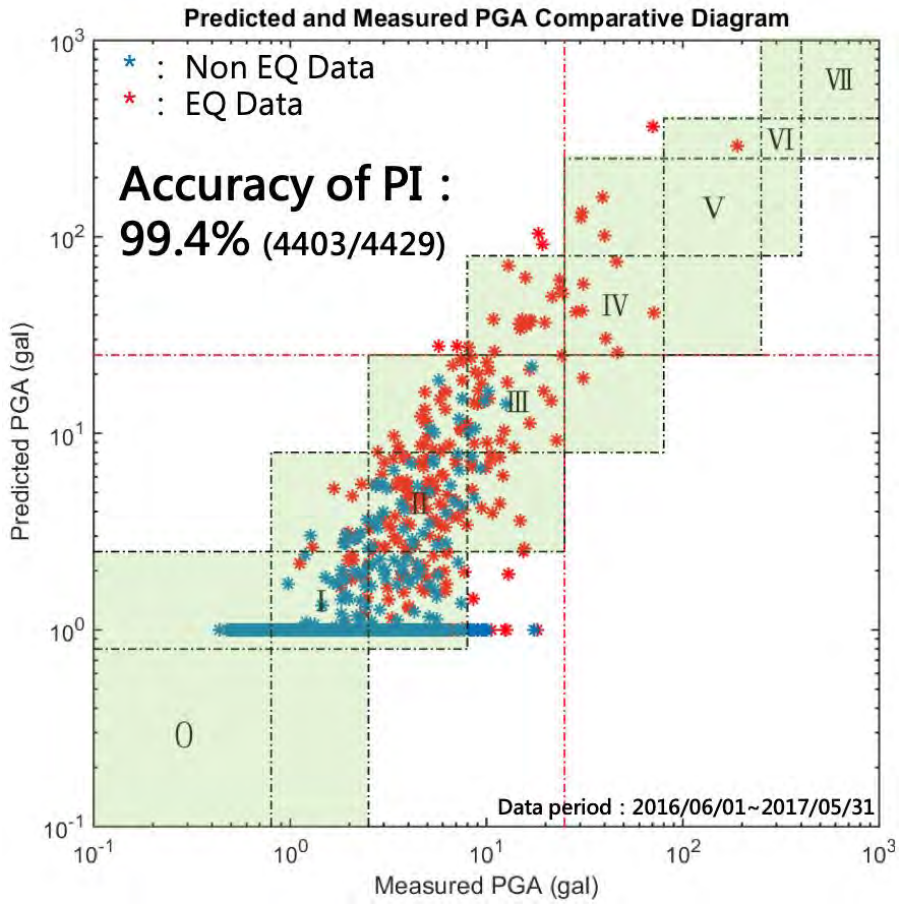

Figure 3: Comparison of the predicted and measured PGA of the on-site EEWS **Click to enlarge**

As the on-site EEWS were successfully applied without the need of a seismic network, NCREE would like to share this with the other countries which are subjected to seismic hazards and lack access to the EEWS service. The first oversea cooperation was established between ISR (Institute of Seismology Research Gujarat, India) and NCREE in 2018. NCREE provide one on-site EEWS, installed in the seismic station of ISR. The on-site EEWS sent a continuous trigger signal, estimated PGA and 3-dir. acceleration through ISR's DAQ and satellite communication back to the Seismic monitoring server in ISR (As shown in Figure 6). Resultantly, ISR can receive the acceleration time histories with the EEWS message (estimated PGA) with the same time and same system. The same system setup has been designed for validation in India. It is believed, with one year of validation, ISR and NCREE will step forward for the application of on-site EEWS in India.

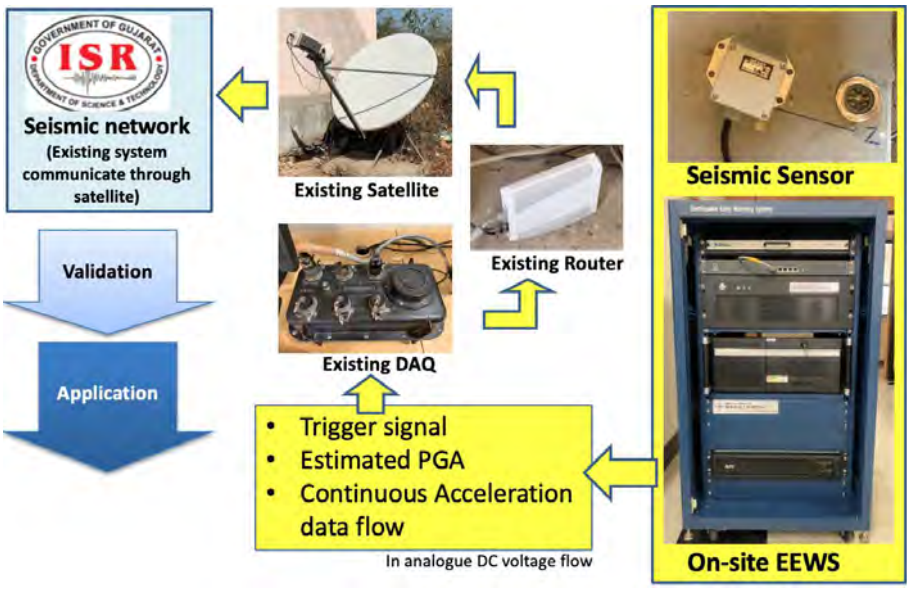

Figure 4: The on-site EEWS demo in India **Click to enlarge**

NCREE

Pei-Yang Lin
Research Fellow
National Center for Research on Earthquake Engineering
Tel: +886 2 6630 0895
pylin0823@gmail.com;
pylin@narlabs.org.tw
www.ncree.org

Opening a window into the Arctic's true impact on the climate

Dylan Browne, Head of Maritime at OneWeb, reveals how we incentivise greater co-ordination and collaboration between researchers across the Arctic

The Arctic's position at the frontier of everything from changing global air currents to fish stocks means what happens in the Arctic matters everywhere else. Scientific research into the Arctic is, therefore, fundamental to predicting and influencing global environmental changes.

For example, ocean currents massively influence global climate conditions and melting Arctic ice is set to flood the seas with freshwater, lowering temperature and salt levels across the world's oceans and producing a resulting ripple effect across global weather patterns.

The Arctic even has a profound impact on the global plastic pollution crisis, with some 1,000 billion plastic particles frozen in Arctic ice, threatening to create a plastic slick across the world's seas.

To compound both these issues, polar regions are warming at twice the rate of the rest of the planet. It is little wonder that a recent Parliamentary report described the region as "both the site and source of some of the world's greatest environmental challenges."

This has driven increased interest in scientific research into the Arctic, with Britain alone investing $7.8 billion in polar research infrastructure including seven polar research stations and a new state-of-the-art polar research ship. The European Union (EU) is also funding many research programmes through its Arctic cluster. These efforts will, however, require an enormous array of new infrastructure to ensure safe and environmentally responsible research in remote and hazardous regions.

Yet the U.S. Arctic still has no deepwater ports and today 48% of the region either has no or little broadband connectivity. Research vessels like Germany's RV Polarstern and RV Heincke currently have to switch between multiple satellite systems for operations in different locations, which comes with its own cost and complexity implications. There are also too few Arctic-wide standards and enabling technologies, resulting in new polar infrastructure being developed in an uneven and un-coordinated patchwork.

This impedes research because the Arctic poses particular challenges to safety and pollution. The remoteness of polar waters and risk of extreme weather combined with difficulties in rescue and recovery, poor navigation and communication are serious risks to research assets in the area.

> "Opening up the Arctic to more research across air and sea and allowing their data to be captured and communicated from any location will create a more comprehensive and current overview of the Arctic and its effects on the world's future climate."

However, there is now a huge opportunity for change. An estimated $1 trillion is being invested in everything from maritime facilities to roads across Canada, Norway, Finland, the U.S. and Russia. This could open up remote polar regions to research and exploration.

Three satellite networks have also recently announced plans to extend coverage across the Arctic, with the first and fastest service the region starting in 2020, which will connect the entire Arctic region. Universal 24/7 connectivity across every part of the Arctic forms a potential enabling infrastructure for universal standards and technologies across the region. This will not only improve safety but also aid the scientific endeavour.

For example, Arctic-wide connectivity will allow ice data to be shared across all polar nations in real-time, boosting safety and providing a holistic real-time

Dylan Browne

window into the impact of climate change on ice cover across the region.

Connectivity will also support the implementation of universal navigational and environmental standards. The International Maritime Organisation's Polar Code now mandates ships in the Arctic be equipped to broadcast ship to shore alerts and able to transmit and receive on-scene communication at all times.

Connectivity will enable research ships to comply with these requirements by facilitating real-time reporting between vessels and authorities, live exchange of hazard warnings and safe navigation within agreed passage plans. It will even allow research stations to remotely train crews by enabling instructors to 'remote in' to vessels and train mariners from any location.

The Polar Code also mandates that ships in the Arctic carry Automatic Identification System (AIS) equipment for safe navigation. Earth's curvature limits the range of AIS to about 74 km from shore, but Arctic-wide satellite connectivity will enable live vessel tracking from any polar location.

> "The Arctic even has a profound impact on the global plastic pollution crisis, with some 1,000 billion plastic particles frozen in Arctic ice, threatening to create a plastic slick across the world's seas."

In this way, connectivity will underpin the standards needed to ensure safe and clean research efforts across all Arctic locations. By permitting the live exchange of everything from ice to climate data across every Arctic location, it will catalyse more collaborative and joined-up research efforts and infrastructure across countries and companies.

Opening up the Arctic to more research across air and sea and allowing their data to be captured and communicated from any location will create a more comprehensive and current overview of the Arctic and its effects on the world's future climate. ■

Dylan Browne
Head of Maritime
OneWeb
partners@oneweb.net
www.oneweb.world
www.twitter.com/oneweb

Drivers of Arctic ice cap change: Linking climate and weather

Martin Sharp, Professor at the Department of Earth and Atmospheric Sciences University of Alberta, Canada, discusses drivers of Arctic ice cap change and his thoughts on linking climate and weather

It is now widely recognised that the Arctic is one of the most rapidly warming regions on Earth and that this warming is driving significant changes in the Arctic cryosphere – the seasonal snow cover, permafrost, sea ice and glaciers that cover much of the Arctic. In general, this warming is more rapid than that occurring at lower latitudes, a phenomenon referred to as "Polar Amplification". However, it is spatially and temporally non-uniform and this has important implications for how it affects the Arctic ice caps. This issue has attracted the interest of glaciologists since the early 1960s. Here I discuss it with particular reference to work that has been conducted on the ice caps in Arctic Canada.

Bea Alt from the Geological Survey of Canada was one of the first to explore the nature of the specific weather systems that generate snowfall and summer melting over ice caps in the Arctic through field studies on the Devon Ice Cap and Meighen Island Ice Cap in the Canadian Arctic (Alt, 1978, 1979, 1983). Through a 14-year (1961-74) study of the Devon Island Ice Cap, she investigated how synoptic weather conditions control variations in the mass balance of the ice cap. She noted that the occurrence of a strong cyclone in Baffin Bay during the summer tended to suppress melt on the ice cap and was often associated with summer snowfall that had the same effect by increasing its surface albedo. Tracking cyclones from elsewhere might add to accumulation on the ice cap, although surface melting might occur if the warm sector of these systems intruded north of Devon Island. By contrast, anticyclonic conditions would result in melting over the outlet glaciers draining the ice cap, while warm air advection associated with anticyclonic blocking would trigger periods of intense melting and mass loss.

The important inference from Alt's studies is that changes in the relative frequency of cyclonic and anticyclonic modes of atmospheric circulation are likely major influences on rates of both snowfall and surface melting on these ice caps – and hence on their mass balance. This idea was picked up in a 1987 paper that explored the nature of the synoptic weather conditions associated with extreme mass balance years in the Canadian Arctic Islands. Three recurring sets of conditions were identified:

- Years with high summer melt, when there was a high-pressure ridge across the islands at all levels in the troposphere and no trough over North America;

- Years with suppressed summer melt, when there was a deep cold trough over Ellesmere Island and down Baffin Bay that encouraged flow into the islands from the Arctic Ocean that suppressed melting and resulted in positive surface mass balance on the ice caps and;

- Years with high accumulation of snow when low-pressure systems tracked south and southeast across the Arctic islands from the Arctic Ocean, producing summer snowfall and positive glacier mass balance.

This was one of the earliest attempts to connect glacier change in the Arctic to variations in synoptic meteorology and climate.

In a 2007 paper, Alex Gardner returned to the theme of Alt's work by linking the record of variability in glacier mass balance in the Canadian Arctic Islands to the history of changes in the position of the summer Circumpolar Vortex in the Arctic. This work was triggered by the recognition of a regime shift in the surface mass balance of glaciers in the Canadian Arctic Islands that took place between 1986 and 1987 and that was associated with a positive shift in summer air temperatures over the region. Gardner showed that annual glacier mass balances tended to be positive in years when the Vortex in July was located in the western hemisphere and negative in years when the Vortex was either weak or strong but not elongated over the Canadian High Arctic Islands and when its centre was

located in the eastern hemisphere. Gardner tracked changes in the atmospheric circulation configuration over time, showing that the occurrence of westerly centred vortices decreased by ~40% after 1987. After that date, atmospheric ridging over the Canadian High Arctic Islands in summer became more common, surface air temperatures increased and regional glacier mass balances became more negative.

By the late 2000s, it was becoming clear that further reductions in glacier mass were occurring in Arctic Canada. Gabrielle Gascon (2013) took up the challenge of understanding how these related to the changing climate. She found that the summer melt season on the Devon Ice Cap became longer between 2004 and 2010 by 3.4 days/year at 1800m elevation, 6.1 days/year at 1300m and 8.8 days/year at 1000m (where the surface melt rate rose from 74 to 133 cm yr-1 from 2007-2010).

These changes were linked to two major drivers: (a) strengthening of the high-pressure ridge over the Arctic in June and July, which resulted in increased advection of warm air into the region, coupled with clear skies over the ice cap, which increased the energy available for melt by 4-24% and (b) increased frequency of south-westerly low- pressure systems in August after 2004 which advected warm air into the Arctic and increased the available melt energy by 12-38% relative to the 2007-10 daily mean, whilst at the same time reducing the shortwave radiation flux and increasing the longwave radiation flux. This had the effect of extending the end of the melt season by an average of ~5.5 days per year at the three monitored elevations on the ice cap. The important message to take from this is that the timing and intensity of melting on Arctic ice caps can vary significantly from year-to-year in ways that are connected to the changing configuration of the regional atmospheric circulation and the nature of the weather systems that it spawns. These influences are, therefore, apparent in records of the mass balance of these glaciers.

In a follow-up study, Peter Bezeau (2015) investigated how glacier mass balance in the Canadian Arctic was affected by variability in the frequency of occurrence of anticyclonic circulation over the region in summer for the period 2007-2012. This was a period when positive summer geopotential height anomalies over the Canadian Arctic Islands were 2.5 times more common than the climatological mean and when glacier mass balances were unusually negative. Various explanations have been proposed for the increased frequency and duration of anticyclonic circulation over the Canadian Arctic between 2007 and 2012, these include increased meridional heat advection and decreasing sea ice extent, sea ice volume and snow-covered area in spring. All of these could potentially contribute to a feedback that would result in an increase in the frequency of positive geopotential height anomalies and anticyclonic circulation in the region. However, the extent to which these changes can be attributed to either natural climate variability or anthropogenic forcing on the climate system has yet to be quantified. Other important points to make are that the timing and rates of climate warming vary across the Arctic so that glaciers across the region will likely respond to warming at different times, at different rates and to varying degrees. It is important to recognise this when trying to imagine how future climate change will impact the Arctic ice caps and to determine how and when the changes that do occur will affect global sea levels and regional scale water resources and water quality.

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UNIVERSITY OF ALBERTA

Martin Sharp
Professor
Department of Earth and Atmospheric Sciences
University of Alberta, Canada
Tel: +1 780 492 8546
msharp@ualberta.ca
www.ualberta.ca/science/about-us/contact-us/faculty-directory/martin-sharp

Conserving and sustainably managing the world's important ecosystems

The Office of Conservation & Water coordinates the development of U.S. foreign policy on conserving and sustainably managing the world's important ecosystems, as we find out here

The Office of Conservation & Water, as part of the Bureau of Oceans & International Environmental & Scientific Affairs (OES/ECW) coordinates the development of U.S. foreign policy approaches to conserving and sustainably managing the world's ecologically and economically important ecosystems, including forests, wetlands, drylands and coral reefs, the species that depend on them and the world's water resources.

OES/ECW also leads on policy formulation to address international threats to nature, such as land degradation, invasive alien species and the illegal trade in natural resources, as well as issues associated with access to and the sharing of benefits from genetic resources – commonly understood as almost any biological material containing DNA or RNA, including cells, tissues and whole organisms of plants, animals and micro-organisms.

The office is responsible for advancing U.S. interests in these areas in a variety of international fora, organisations, institutions and treaties, negotiating effective, evidence-based agreements and promoting their enforcement, developing international initiatives with key partners to employ market forces and creating a foreign policy framework in which public-private partnerships that promote U.S. interests can flourish.

Access & benefit-sharing

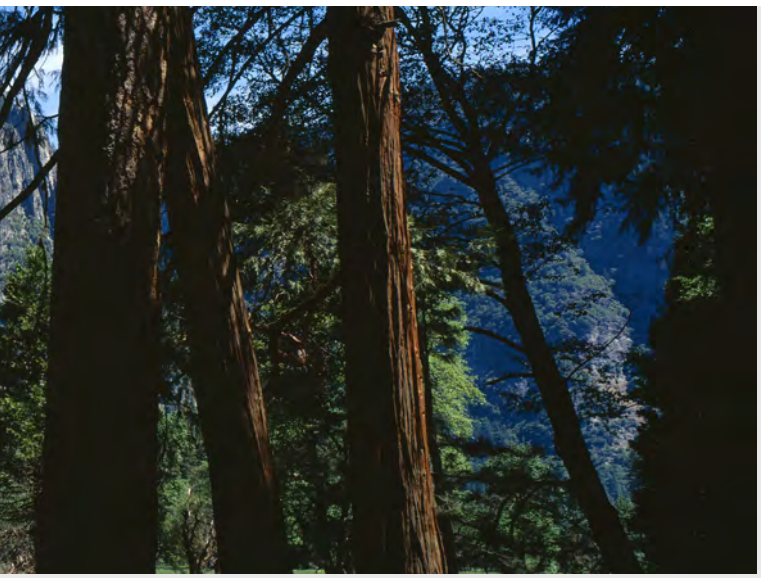
Genetic resources are important to innovation and the development of new products across a number of sectors, including pharmaceuticals, agriculture and cosmetics. As a leader in public and private genetic research and development, the U.S. has a strong interested in international and country-specific approaches that support access to and benefit-sharing from genetic resources.

The ECW leads on policy development, working with relevant U.S. agencies and ensures that U.S. stakeholders are kept up-to-date with the changing international ABS landscape.

Conservation

The conservation, use and management of resources such as food, water, fuel, medicines and ecosystems provides the foundation for healthy, resilient communities and economies, which in turn promotes stability and prosperity around the world.

ECW leads U.S. participation in a range of international and intergovernmental processes to promote conservation and is also responsible for international policy issues related to invasive species, migratory birds, parks and protected areas, pollinators, sustainable tourism and wildlife conservation.



Forests

The U.S. imports and exports more than $50 billion in forest products annually, as part of more than $200 billion in global trade. The United States is also one of the top five countries in the world in terms of forest cover and is a leader in forest management practices, education and research.

As policy lead within the Department of State, ECW seeks to expand U.S. expertise and leadership in forest management, address market distortions that can disadvantage U.S. industry, reduce corruption, promote stability in rural communities worldwide and advance U.S. forest practices around the globe.

Genetic resources for food and agriculture

Food security cuts across many key issues in conservation, from stable and healthy land and pollination to sustainable water resources and resilience to pests and diseases.

The ECW leads U.S. participation in a range of intergovernmental and international processes to ensure U.S. farmers, plant and animal breeders and researchers have access to genetic resources (such as seeds or other propagating materials) needed to achieve food and water security.

Water

By 2025, two-thirds of the world's population will live in "water-stressed" conditions, including almost two billion people who will not have enough water to meet human, industrial and ecosystem needs.

Scarcity and poor quality of water will increase disease, undermine economic growth, hit food production and become a growing threat to peace and security in many regions.

ECW leads U.S. foreign policy on drinking water and sanitation, water resources management and transboundary water and conflict issues. It coordinates the development of policies and positions across the U.S. government, including implementing the President's Global Water Strategy, representing the U.S. in bilateral, regional and global fora to advance policy interests, facilitating conversations between countries where water source is a tension and managing programmes that leverage U.S. knowledge and resources to advance policy interests on water and sanitation.

Wildlife trafficking

The illegal poaching, transit, trade and sale of wildlife generates more than $10 billion a year for international organised crime networks. It also has devastating impacts on security, economic development while fuelling corruption and pushing species to the brink of extinction. The multifaceted nature and global scale of the problem calls for strategic cooperation at global, regional, national and local levels.

The U.S. is one of the world's biggest markets for both legal and illegal wildlife and wildlife products and, as such, the U.S. government takes a key role in addressing wildlife trafficking.

ECW acts as co-chair of the Presidential Task Force on Wildlife Trafficking, which coordinates inter-agency efforts to strengthen enforcement, reduce the demand for illegal products and expand international commitments across multilateral, regional and bilateral forums.

ECW also coordinates efforts to implement the END Wildlife Trafficking Act, which was signed into law in October 2016. ■

Open Access Government
editorial@openaccessgovernment.org
www.openaccessgovernment.org
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The Biosphere: Global limits of human habitability

Here, Dr Steven Running dives into the questions of Net Primary Product and ongoing climate change, to illuminate what the global limits of the biosphere are

One of the foundational principles of biology is that a population cannot grow forever in a finite ecosystem, in this case the Earth. Systems ecology theory predicts when resource limits are exceeded, a progressive system feedback of starvation, predation, and disease limits uncontrolled population and consumption growth. The global human population has now nearly tripled since 1950, and economic activity increased tenfold, leading many to suggest that humanity is heading toward a population and consumption overshoot and correction this century. The global population, currently at 7.5 billion people, is projected to rise beyond 10 billion by 2100. Future limits become an urgent policy issue when one considers the expansion in living standards aspired to by the underdeveloped world. Is humanity smart enough to anticipate global overshoot, and shift to sustainable policies before these morally unacceptable systems feedbacks take over?

Net primary production, or NPP, usually in units of kg/ha (or equivalent) of plant biomass, is the core metric scientist use for quantifying total plant growth over broad areas without worrying about the complicating factors of species, yield fraction or other details. Because of these simplifications, NPP can be measured for entire regions, countries, and ultimately the whole biosphere. Feeding people is a moral imperative, yet global NPP data does not now show sufficient increases in crop production to meet these future needs.

> "As the Earth's population continues to increase, and climate continues to change, consistent monitoring of NPP will become an even more essential tool for understanding and mitigating damage caused to the biosphere."

Plant material is also the source of wood fibre for construction and paper products, and for bioenergy – a renewable energy source such as wood, agricultural waste and specifically-grown energy crops, which is burnt for heating, cooking or electricity production. In the future, bioenergy could meet a proportion of our energy needs, as the net carbon footprint is far lower than that of fossil fuels. However, our current estimates vary greatly due to unknown factors, such as the future availability and productive potential of land, which needs to be balanced with food production to feed the growing human population.

While food, fibre and fuel are obvious consumption of biospheric NPP, non-consumptive uses are also of prime importance, particularly climate stabilisation. Photosynthesis continually removes carbon dioxide from the atmosphere, land-based plants absorb around 30% of the carbon dioxide that human activity adds to the atmosphere, demonstrating the critical role of NPP in climate change mitigation. Accurate NPP values are vital for scientists who are trying to understand and predict the severity and effects of future climate change on the biosphere. If NPP is degraded, atmospheric carbon dioxide would increase faster, and global warming would accelerate. Conversely, if humanity can enhance NPP it slows global warming down.

Until recently, measuring NPP continuously on a global scale was not possible. Most previous estimates have been made by taking measurements of plant biomass from a small plot and roughly extrapolating them to calculate global NPP. To obtain a more accurate picture, I started to work closely with NASA in the early 1980s as a member of the development team of NASA's Earth Observing System. This fleet of satellites has been monitoring the Earth's land, oceans and atmosphere for 20 years. The Terra and Aqua satellites are part of the Earth Observing System and are equipped with a Moderate Resolution Imaging Spectroradiometer (MODIS). For my algorithm, MODIS measures the proportion of Earth's land surface that is covered in vegetation and the reflected sunlight in special wavelengths.

My lab developed an algorithm to assesses the amount of sunlight that can be absorbed by vegetation, along with the local weather conditions, to calculate the rate of photosynthesis, and therefore the amount of carbon

dioxide that is being absorbed, producing now a large dataset of continuous global NPP measurements. NASA releases new NPP data every eight days, where it is used by various groups, including NASA, government organisations, many other countries and private landowners to aid in land management.

"Photosynthesis continually removes carbon dioxide from the atmosphere, land-based plants absorb around 30% of the carbon dioxide that human activity adds to the atmosphere, demonstrating the critical role of NPP in climate change mitigation."

During our early research, we identified various climate factors that limit the rate of photosynthesis and plant growth in different regions. The team found that temperature is limiting at high latitudes but overall, water availability is the most important factor. The team's long-term monitoring of NPP has helped us to understand how changes in climate can affect global NPP. For instance, rising temperatures increase growing season length, but decrease water availability, and many of the NPP trends identified can be directly attributed to these effects. We showed how significant droughts between 2000 and 2009 caused the reduction in NPP in the Southern Hemisphere. Decreases in cloud cover increased sunlight over tropical areas causing the largest increases in NPP, particularly in the Amazon rainforest. It initially appeared that rising global temperatures were having a positive effect on the growth of plants, potentially increasing their ability to act as a sink for excess carbon dioxide produced by human activity. However, the reduction in NPP from 2000 to 2009 from drought effects raises serious issues. If rising global temperatures reduce plant growth, the ability of vegetation to act as a carbon sink will be reduced, accelerating climate change.

This NPP data is also vital for landscape management, optimisation and planning. Is the Amazon rainforest more valuable as a carbon sink mitigating climate change, or as a food production source? Are trees in a savannah more valuable as a fuel supply, or for carbon sinks and wildlife habitat? What is the most sustainable intensity of grazing on rangeland? The answers to these priorities are different for each tract of land that has differing potential for NPP, and local demands by humanity for consumptive and non-consumptive uses. NPP from a biodiverse ecosystem provides wildlife habitat, and aesthetic landscapes for human recreation, note the huge popularity of U.S. National Parks. There is clear potential for conflicting priorities between consumptive uses, and non-consumptive uses of our ecosystems.

An example of conflicting uses of NPP is whether land should grow crops for food, or for bioenergy. It has been suggested that biofuels could substitute for fossil fuels as part of stabilising climate, so we investigated the maximum global primary bioenergy potential. We calculated a potential bioenergy capacity that is four times lower than previous estimates and would require 55.6 million square kilometres of natural vegetation to be converted to bioenergy cropland – an area greater than Asia and Europe combined! The conversion of natural ecosystems to cropland is not only destructive to the environment, but would also significantly reduce the amount of carbon that can be sequestered, reducing climate stabilisation potentials. By 2050, the demand for global energy is predicted to double, but we suggest that bioenergy can only meet less than 15% of global energy needs in a sustainable manner.

As the Earth's population continues to increase, and climate continues to change, consistent monitoring of NPP will become an even more essential tool for understanding and mitigating damage caused to the biosphere. It is essential for humanity to not reach catastrophic planetary limits risking collapse. There is no better and available global dataset than NPP, the foundation of food, fibre, biofuel and climate stabilisation, for this essential monitor of global habitability.

Dataset:

https://lpdaac.usgs.gov/products/mod17a3hv006/

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Numerical Terradynamic Simulation Group

Dr Steven Running
Numerical Terradynamic Simulation Group
Tel: +1 406 531 5947
steve.running@mso.umt.edu
www.ntsg.umt.edu

Promoting and supporting research and innovation in Canada, including climate change

Here, we examine the role of the Natural Sciences and Engineering Research Council of Canada in promoting and supporting research and innovation, for example, in the area of climate change

The Natural Sciences and Engineering Research Council of Canada (NSERC) sets out to "to make Canada a country of discoverers and innovators for the benefit of all Canadians". To introduce their work, NSERC promotes and supports discovery research, facilitates innovation by encouraging Canadian organisations to invest in and take part in post-secondary research projects and supports students in advanced studies. Researchers at NSERC are on, "the vanguard of science" and perhaps in a way, they are continuing the country's long tradition of building on scientific excellence. (1)

Investing in climate change research

This article will focus on how climate change is being supported in Canada. In a recent press release from NSERC, we learn that according to science, climate change is real today. Investing in science is a win-win situation because it really supports the researchers who make the discoveries required to combat climate change and adapt to its impacts. Certainly, the people of Canada expect the government to make decisions with a firm grounding of scientific evidence. As such, Canada will keep supporting cutting-edge science to help protect future generations.

In July 2019, the Honourable Catherine McKenna, Minister of Environment and Climate Change, announced $4.7 million for nine climate change research projects. These projects are important as they will further human knowledge of the role forests play, improve our understanding of how carbon interacts with our wetlands, forests and oceans, and accelerate innovation in energy-efficient cooling technologies.

These projects are funded by the Advancing Climate Change Science in Canada initiative, a collaboration of the Natural Sciences and Engineering Research Council of Canada (NSERC), Environment and Climate Change Canada (ECCC) and Health Canada (HC). The projects will increase the available scientific information so that government decision-making on climate action is well-supported.

The Minister of Environment and Climate Change said: "Science clearly shows us the causes of climate change, and our government is supporting the scientists who we know will show us the solutions. Working with scientists and academics will help us keep pushing forward in the fight against climate change. By coming together and working collaboratively, we can ensure a safer, healthier, more prosperous future for our children and grandchildren."

Dr Marc Fortin, Vice-President, Research Partnerships, Natural Sciences and Engineering Research Council of Canada added: "Congratulations to all recipients. This initiative is an excellent example of NSERC's commitment to working with other government partners to achieve research outcomes that generate benefits for Canada. This important investment supports research that will address the complex and interdisciplinary nature of climate change science for a more prosperous future for all Canadians." (2)

Support for skills and training

Let's finish by casting our minds back to the start of this article which included the aim of NSERC to supports students in advanced studies. In July 2019, we find out that the Government of Canada is investing in projects to get students job-ready for careers in research. Certainly, the government understands that by giving researchers the chance to learn and grow, the future of the economy and the next generation of innovators are being invested in.

An investment of $29.6 million through the Collaborative Research and Training Experience (CREATE) program of

the Natural Sciences and Engineering Research Council of Canada (NSERC) was announced in July 2019. We know that this will permit 18 research teams of students and post-doctoral fellows to apply new knowledge to develop the skills required to help them in their future careers. Also, we know that the CREATE grants very usefully support research teams across Canada working in a wealth of areas such as blockchain technology, cybersecurity, soil science and industrial engineering.

On this, Danika Goosney, NSERC Vice President, Research Grants and Scholarships said: "CREATE supports outstanding mentoring and skills training opportunities for students, complementing their science and engineering research training. The result is a cohort of early-career scientists and engineers with a greater potential to become tomorrow's dynamic leaders."

This and the other areas explored in this article are just a part of the wider work of the NSERC, who invests over $1.2 billion annually in Canada's natural sciences and engineering research. Long may these worthy investments continue to deliver research discoveries and enable partnerships and collaborations. [3]

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How plants regulate their body temperatures: Implications for climate change science & policy

Peter G. Kevan, University Professor Emeritus at the School of Environmental Sciences, University of Guelph, explores here how plants regulate their body temperatures, including the implications in this respect for climate change science & policy

The temperature at and near the Earth's surface is rising, much to the consternation of the world.

Terrestrial life, including human, is almost all restricted to a biofilm of few tens of metres above and below the surface. That life-supporting film, the biosphere, has, by comparison with the atmosphere, lithosphere and hydrosphere, the greatest historical, seasonal and daily variation in environmental conditions, including temperature, moisture, solar radiation, atmospheric disturbances, electromagnetic fluxes and chemical composition. Life forms have adapted to those wide swings in environmental conditions and notably to temperature.

It is well recognised that the diversity, abundance and activities of terrestrial life are influenced by two main climatic factors, temperature and water availability. Warmth and water favour life. Environmental temperatures may be too cold or too hot to allow certain life forms to thrive. Environmental moisture has more complex direct and indirect effects on life. There are, additionally, other environmental factors (e.g. salinity, pH, the nature of substrates) that influence life. Global concern for climate change invokes the effects of the atmospheric build-up of greenhouse gases. Global climate change influences all those factors as life's diversity, distribution, abundance and activities are affected. The effects of global climate change on life are mostly inferred from general meteorology without much consideration for the actual environmental conditions close to the ground (micrometeorology) and within life forms (biometeorology). Micrometeorology and biometeorology must be applied to refining scientific understanding of the extent and consequences of climate change.

Micrometeorology provides a more accurate and complex appreciation of ambient conditions affecting life, its diversity, abundance and activities. Biometeorology, in dealing with the relationship between living things and the weather, takes meteorology more directly into biology by seeking general, ecological, physiological and genetic explanations into the processes whereby ambient conditions influence life, its diversity, abundance and activities.

A prime example of how climatology, meteorology and biometeorology combine is presented by geographical patterns (maps) of plant growth and survival, especially as used for agriculture and the predictive utility of heat units (often expressed at growing degree days) and rainfall in farming. Intrinsic to those patterns are micrometeorological effects, amounts of direct and diffuse insolation, as well as atmospheric humidity and wind. The actual temperatures within plants are missing from biometeorological consideration.

Biothermometry (the measurement of body temperatures) is widely applied in medicine, but less often in other biosciences. For medicine, deviations from normal body temperature are regarded as symptomatic of ill health or stress. Human beings, mammals and birds maintain constant and closely regulated body temperatures and are strict homoeotherms (endotherms). Most other animals, plants and fungi are usually considered poikilotherms (ectotherms) even though many have various means to control their body temperatures. Biothermometry has been applied to plants through direct measurements and by remote IR thermometry.

For flowers, the means of warming under cool conditions have been recently reviewed (van der Kooi et al. 2019)[1] and include solar basking by orientation of plant parts to face the sun, closing of leaves or floral parts and so retaining heat, adaptations that emulate translucent miniature greenhouses and, in some special cases, metabolic heating.

For other plants parts, notably stems, Kevan et al. (2018)[2] present data

showing that hollowness imbues plants with elevated temperatures in sunny conditions. Cooling under heat stress is less understood. Apart from the orientation of leaves by paraheliotropism to reduce solar heating, cooling is attributed to transpirational heat loss (i.e. heat loss by the evaporation of water through stomata, akin to sweating). The cooling effect of trees is not simply by shading but includes transpiration and may involve paraheliotropism. Those phenomena are increasingly invoked for mitigation of heat in urban landscapes. Herbaceous plants may also exhibit paraheliotropism and so reduce incident solar heating stress, but, additionally, show growth responses mediated by interacting heat and light sensitivities that result in heat avoidance.

Thus, plants, although apparently static and passive, show remarkable capacities to regulate their internal temperatures by a complex variety of strategies. Those include solar heating, as in diaheliotropic solar furnaces (Kevan,1989)[3], microgreenhouse effects (Kevan et al 2018, 2019)[4,5], metabolic endothermy (van der Kooi et al. 2019)[1] and concomitant cooling by evapotranspiration (the swamp cooler effect (Galen C, 2006)[6], paraheliotropism and adaptive morphogenesis (Crawford et al, 2012).[7] Thus, plants are, as Michaletz et al. (2015)[8] argue, but from the viewpoint of metabolism, limited homoeotherms!

A major consequence of plant thermoregulation is atmospheric air conditioning. Transpirational evaporation humidifies the atmosphere above the vegetational canopy. With nocturnal, altitudinal and adiabatic atmospheric cooling, moisture in the air condenses as the dew point is reached – clouds form and rain may result, sometimes with violent electrical discharges (thunderstorms). The more humid the air, as over forests, the lower in the atmosphere the processes are initiated. By comparison, drier and hotter air rises further, even if somewhat faster, to possibly form thinner, higher clouds that may be blown away. Deforestation, devegetation and desertification forestall, or even preclude, autochthonous, locally derived, moisture cycling. Those processes, exacerbated by global heating and the influence of increasing oceanic evaporation, may contribute considerably to extreme weather events far from the sites of forest thermoregulation.

Numerous means for the mitigation of the effects of climate change are advocated and instituted. Strategies range in scale from macro to micro; from direct intervention on atmospheric chemistry (reducing the influx of anthropogenic greenhouse gases, cloud seeding), indirect environmental amelioration (irrigation, reafforestation, smoke smudging), to genetic manipulations (cold, heat, drought and pest tolerant crops and livestock). Plant thermoregulation and its consequences are hardly understood in terms of climate change.

A new, dynamic and highly interdisciplinary, scientific approach to phytomicrometeorology is needed. The cast of players must range from theoretical physicists with interests in atmospheric thermodynamics, to climatologists, meteorologists, micrometeorologists, botanists of all stripes and eclectic ecologists.

With many organisations advocating the need for scientifically based policy, especially for national and international laws and accords on pressing environmental issues, it is vital that policymakers embrace broader perspectives than have been usually taken for initiating action. Governments around the world need to sponsor far-reaching and more expansive, approaches to environmental sciences, especially as they relate to the drivers of local to global climate change. The importance of vegetational thermoregulation in mitigating the effects of both cold and heat, i.e. plants as limited, but highly environmentally influential, homoeotherms, seems like an overlooked dimension to understanding the world's climate problems and in possibly seeking solutions.

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Peter G. Kevan, B. Sc., Ph. D., FRES, FRSC, FRSB, FLS
University Professor Emeritus
School of Environmental Sciences
University of Guelph
Guelph, Ontario N1G 2W1, Canada
Tel: +1 519 824 - 4120 extension 52479
Home: +1 519 658 0573
pkevan@uoguelph.ca

Advances in plant pathology: Impact on tomato diseases

Aarthi Janakiraman, Industry Manager, Chemicals and Advanced Materials at TechVision, Frost & Sullivan, discusses advances in plant pathology, with a focus on the impact of this on tomato diseases

Tomatoes are among the economically important vegetable crops grown, with around 200 million tonnes produced globally. While China and India are the largest growers of the vegetable, countries like Morocco, Turkey, European nations such as The Netherlands, Spain, France, Belgium and the U.S. are also prominent. There are hundreds of varieties of tomato for growers, the choice depending on varying preferences including taste, texture, colour, size and bush type to name a few. Many growers prefer to grow two or more varieties of tomatoes, including at least one heirloom varieties mainly due to the breed's popularity and suitability to UK's climate. However, the flavour-rich heirloom tomatoes are often susceptible to diseases many of the commercially available disease-resistant varieties are not characterised by a rich flavour.

Tomatoes generally grow well in a moderately well-drained soil type and various biotic and abiotic factors influence its production and yield apart from physiological factors such as wind patterns, temperature, humidity and inherent varietal resistance, often resulting in blossom-end rot, fruit cracks and uneven ripening. These physiological conditions also play an important role in ensuring productivity and yield. The most common problems for the crop are caused by low temperatures, over-watering or wet weather. Therefore, it is important to ensure good aeration, water drainage, light and proper nutritional balance of the soil. Judicious use of herbicides is also necessary to avoid curling, stunted growth, discolouration of leaves, strapping etc.

Identification and control of infectious diseases in tomato

Infectious diseases reduce yield and affect produce quality, the most common categories being wilts, leaf spots/blights, fruit spots and rots. Most of the pathogens are fungal in origin with bacterial- and viral-borne infections close behinds with symptoms varying with the host. However, there are certain definitive symptoms that help in the positive identification of the target pathogen. For example, the presence of a yellow halo surrounding a tan to the dark brown lesion is an indication of bacterial infection despite the symptom being absent when bacterial spots and blights occur. Fungal blight (especially late blight) is considered as one of the deadly diseases that can affect tomatoes and its impact is devastating just like it is in potatoes and other crops.

Viruses are highly infectious and readily transmitted by any means. Different symptoms including light and dark green mottling of the leaves can occur because of viral attacks. For example, tobacco mosaic virus (TMV) causes mottling of older leaves and may cause the malformation of leaflets, which may lead to shoestring-like in shape. Certain symptoms of viral infections are characterised by leaf mottling, curling, stem and petiole streaking, spotted fruit and stunted plants; these symptoms can sometimes be confused with herbicide damage. Therefore, it is imperative for proper identification and understanding of the disease agent and its ability, determining if it's infectious or not, to devise and implement proper control and corrective measures.

The use of disease-resistant varieties, certified disease-free seeds, crop rotation practices, sequential planting, sanitation (removal of crop debris) and ensuring proper nutrition, aeration and drainage can to a certain extent, prevent the occurrence of diseases; however, integrated preventive and control measures are still important to ensure product quality and yield.

European Union (EU) regulations have reduced the availability of chemical control measures and the current measures, while effective during early stages of the disease are often unsuccessful at later stages, especially for diseases such as late blight and result in

the destruction of crops, without any effective ways to control the spread of the disease. Therefore, the selection of disease-resistant varieties has become one of the widely adopted methods to prevent diseases. Despite its success, it cannot be an effective alternative for integrated pest management (IPM) measures and integrated glasshouse management (IGM) in case of cultivation in more controlled glasshouse and indoor environment. To successfully implement IPM, it's critical to understand the interactions between plants, environmental conditions, disease-causing agents and its effect on growth, yield and quality; continuing advances in plant pathology studies makes it feasible and can help achieve positive results in disease prevention and control.

Research advances in plant pathology: Need of the hour

While plants inherently develop ways to resist and deal with pathogenic attacks, it's also common that pathogens are becoming more resistant to control measures and counterattack the plants defence mechanisms. Therefore, the earlier approach of studying only the influence of biotic factors on plant growth is no longer relevant. Pathology studies are increasingly focusing on molecular and gene- level interactions of pathogens and plants rather than only morphological and physiological influences. Varying approaches for disease management and prevention are being researched, ranging from encapsulating nanoparticles of HarpinPss to improve disease resistance, use of growth-promoting agents to enhance biological resistance of diseases, use of gene silencing techniques for improved resistance and combat diseases, apart from a continuing focus on developing biological plant protection aids.

Researchers are also set to develop high-throughput diagnostic technologies, based on nano-sequencing techniques. The possible use of deep learning platforms and neural networks for real-time detection of tomato plant diseases and pests are also being investigated.

Despite various initiatives, there are still significant gaps in research that can result in the development of fool-proof ways to monitor for potential attacks, scan and monitor for the possible onset of new diseases. There is also a need for initiatives that can help in contingency planning to prevent potential vulnerabilities and future threats. Studies on integrated approaches that can lead to efficient and sustainable cultivation, harvesting and post-harvesting techniques are needed to ensure nutritional quality and microbiological integrity of tomato produce. This can be achieved only through collaborative and joint efforts of all stakeholders, ranging from growers associations to academia and private companies. With consumer requirements towards "clean-label" and high-quality produce at an all-time high, it is important that key stakeholders focus on research, development and implementation of techniques that can not only ensure yield and profitability but also guarantee the nutritive value and quality as demanded by the end-consumers. ■

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Aarthi Janakiraman
Industry Manager, Chemicals and Advanced Materials
TechVision, Frost & Sullivan
Tel: +91 44 6681 4102
aarthij@frost.com
ww2.frost.com
www.twitter.com/Frost_Sullivan

Plant pathology: The global impact of wheat diseases

Dr Kim Hammond-Kosack at Rothamsted Research highlights an aspect of plant pathology that concerns the importance of finding new ways to disarm old enemies in wheat diseases

Wheat is the number one arable crop grown in the UK and Europe, and globally, the wheat crop provides 20% of the total calories consumed by humans each day. Wheat is also a valuable source of animal feed and is increasingly used in a wide range of manufacturing processes. The EU harvested 142.6 million tonnes of wheat in 2017.

Currently, wheat yields are not resilient to adverse weather conditions or various biotic and abiotic stresses.

As a result, 'on farm' yields remain static. Each season because of diseases caused by microscopic pathogens, predominantly specialist infectious fungal, bacterial and virus species, potential wheat yields are reduced by 16 to 25%. Pathogens rapidly grow and reproduce within wheat plants and spread disease to neighbouring fields and regions thereby causing disease epidemics and pandemics if left unchecked. Collectively, these pathogens reduce crop canopy, root system and flower health thereby lowering grain yield, quality and sometime grain safety.

Within the wheat pathogenomics research team at Rothamsted we focus on several pathogenic fungi of global importance. In this article we will feature two persistent disease problems of fungal origin which are causing the agrochemical industry, plant breeders, agronomists and farmers frequent headaches. The first leaf blotch disease is caused by *Zymoseptoria tritici* and the second Head blight disease is caused by a group of Fusarium species (Figure 1).

Our multi-disciplinary team includes plant pathologists, molecular biologists, geneticists, computational biologists and field crop scientists. We are pursuing a two-pronged experimental approach. On the one hand we investigate how fungi attack wheat and cause disease by discovering the genes, proteins and chemical metabolites involved, as well as defining the underlying interconnecting networks which co-ordinate the early infection process.

In concert with this, we are exploring the molecular processes used by wheat cells to perceive fungal pathogen attacks as well as dissecting the plant defence components that are activated to rapidly stop fungal growth and minimise disease formation. In recent years, our discovery research toolbox has been substantially improved thanks to the full sequences of pathogen and wheat genomes becoming available (i.e. their DNA blueprints).

Finding pathogen genes required for stealth or attack

To be successful, a pathogen needs initially to attach itself to, and then grow along, across and ultimately into, plant tissues. Whilst doing so it must also mask its presence and remain symptomless, until its size and strength becomes sufficient to overwhelm the plant and cause disease. Our group has identified several key genes from both Fusarium and Zymoseptoria species which are important for these events. By randomly inducing mutations into the genome of Zymoseptoria and then testing for mutants which could not grow on leaf surfaces, we've identified a key virulence gene *GT2* (a specialist enzyme called glycosyltransferase 2). The identical Fusarium gene is also crucial for the infection of wheat floral tissues. Inactivation of these genes would likely protect plants from the corresponding diseases. We've also identified a key "stealth" gene called *3LysM* which prevents Zymoseptoria being recognised early on by the plant's defences, thus giving it time to build up inside the infected wheat leaves. Blocking this fungal gene would also likely prevent disease.

Finding wheat genes required to stop pathogens

To be successful, a plant needs to recognise an invading pathogen and rapidly switch on an effective defence response as well as prepare for subsequent attacks.

Despite Zymoseptoria being such an important wheat pathogen, only a small number of genes for resistance to Zymoseptoria have been identified so far and surprisingly very little is known about how these genes actually operate to protect wheat.

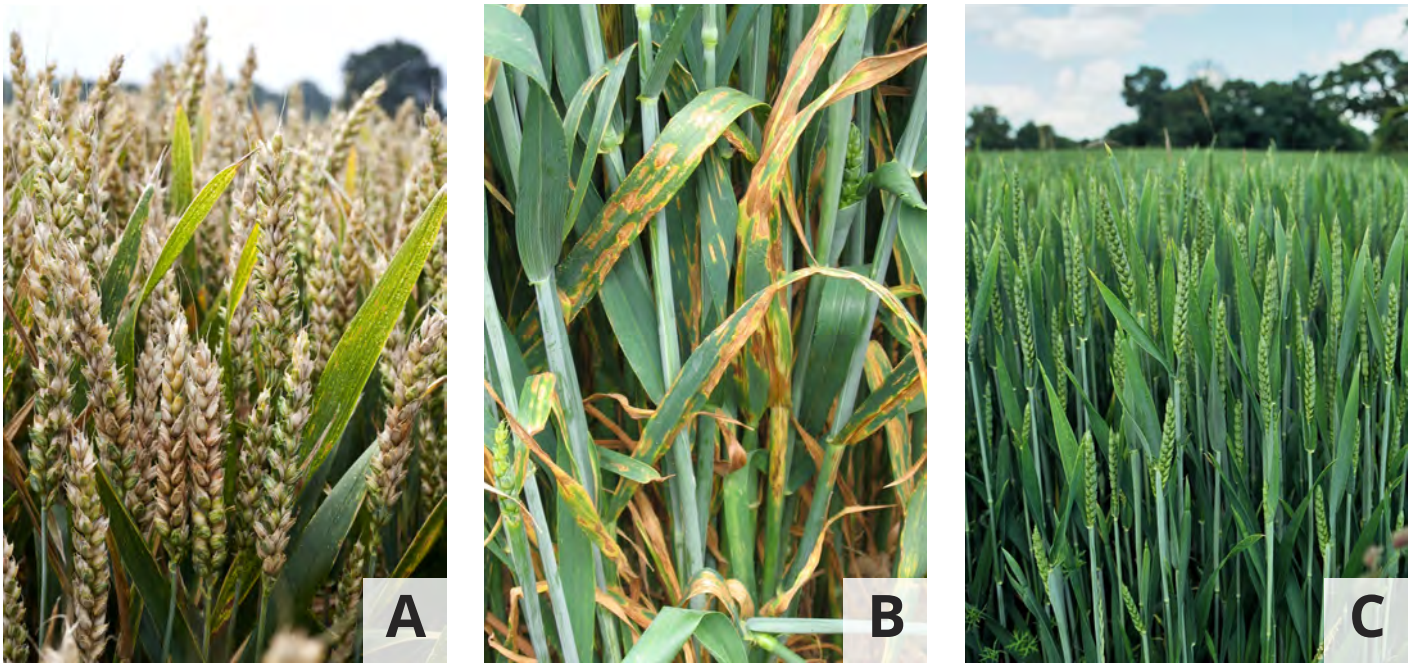

Figure 1 (A) Fusarium Head Blight. Fusarium species infect the flowering crop causing premature bleaching of floral tissues. Infection results in lower quality grains contaminated with hazardous mycotoxins that are regulated by the European Food Safety Authority. (B) Septoria Leaf blotch. Zymoseptoria tritici causes the complete death of infected wheat leaves, preventing the plant from capturing sunlight needed for plant growth. Both fungal species are either partially to fully resistant to all commercial fungicides. (C) A healthy wheat crop.

To help us answer some of these questions, we isolated the very first Zymoseptoria resistance gene from wheat known as Stb6. This gene belongs to a large previously uncharcterised gene family in wheat, codes for a cell wall residing immune receptor protein that senses a protein secreted by Zymoseptoria during attempted infection and triggers defence.

Unravelling the molecular mechanism of Stb6 mediated resistance will help inform future effective strategies for disease control. Moreover, the knowledge already gained in our studies will help to isolate additional resistance genes for deployment through breeding in wheat improvement programmes.

Outlook

The most sustainable solution to reduce plant diseases is through delivering life-long protection within or on the planted seed. This can be achieved by combining a triad of approaches. Through plant breeding by 'stacking' or 'pyramiding' multiple disease resistance genes that activate different plant defences against the same pathogenic species.

By removing or inactivating disease susceptibility genes that were unwittingly incorporated into elite cultivars by breeders when introducing another, beneficial trait. Through the application of novel chemicals or biological agents to the seed in coatings that go on to combat infections throughout the life-span of each plant by reducing the effectiveness of pathogen stealth or attack genes.

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Wheat Genetic Improvement Network

Dr Kim Hammond-Kosack
Research Programme Leader Wheat Pathogenomics
Rothamsted Research
Tel: +44(0) 158 293 8240
kim.hammond-kosack@rothamsted.ac.uk
https://www.rothamsted.ac.uk/our-people/kim-hammond-kosack
www.twitter.com/WPT_Rothamsted
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Protecting U.S. agriculture from pests and pathogens

APHIS, part of the USDA, is using a risk-based approach to protect U.S. agriculture from potentially devasting plant pests and diseases, as we discover here

The Animal & Plant Health Inspection Service (APHIS) is an agency of the United States Department of Agriculture (USDA). It has a wide-ranging mission to protect and promote U.S. agricultural health, regulate genetically engineered organisms, administer the Animal Welfare Act and carry out wildlife damage management activities.

A key element of the agency's work is the ongoing protection of animal and plant resources from pests and disease.

The potential damage of major agricultural pests, such as the Mediterranean fruit fly or Asian long-horned beetle, going unchecked could run into the billions of dollars in lost production annually.

Similarly, if diseases like Foot and Mouth or highly pathogenic avian influenza became established in the United States, it could lead to foreign trade restrictions and devastating losses for producers.

The Plant Protection Act 2000 was introduced to prevent the importation, exportation and spread of pests and to provide for their control and eradication, as well as to provide for the certification of plants.

The act consolidated related responsibilities previously split between several other laws, such as the Plant Quarantine Act, the Federal Plant Pest Act and the Federal Noxious Weed Act.

APHIS takes an aggressive approach to pest control and in recent years has focused on improving a risk-based approach to simplify processes for dealing with low-risk pests and pathogens while allowing greater resources to be focused on high-risk categories.

In 2016, the USDA's Plant Protection & Quarantine (PPQ) programme introduced risk-based sampling for imported agricultural commodities.

While the most commonly applied plant health measure worldwide, inspection is not necessarily the most efficient tool for keeping pests out of the country, the APHIS said at the time. In addition, most inspections sample a flat percentage, for example, 2%, of every incoming shipment. This approach is widely used

around the world but does not produce consistent detection rates for pests: a 2% sample of a large shipment could inflate detection rates because a large number of samples are taken, whereas with a 2% sample of a small shipment, detection rates can be underestimated, particularly if infestation rates are low.

To make port inspections more effective, the PPQ analysed data to identify high-risk imports without increasing the inspection effort or resources. To do this, scientists employed an online tool that effectively reverse-engineered the process by using a selected detection rate to calculate a statistically appropriate number of units to inspect from each incoming shipment at the PPQ's 16 Plant Inspection Stations.

Since the change, PPQ inspectors have detected pests at a consistent level because they know how many boxes they need to sample to confidently determine if there is a problem with a shipment.

More recently, APHIS revised the regulations that govern the movement of plant pests to align them with current policies, remove obsolete requirements and streamline the permit process for low-risk organisms.

The changes, which came into effect on 9th August, means listed plant pests used by academic, industry and government researchers for activities including studies of micro-organisms, the isolation of novel compounds for use in pharmaceuticals, biological control and lab and field research into plant pest control and resistance, can be moved without a specific permit.

The rule also applies to private sector entities, such as zoos, biologically based pest control companies, butterfly release enterprises, some live pet food retailers and speciality retailers that sell products for human consumption.

The changes are intended to make permit requirements clearer and more transparent for customers, while making the permitting process faster for low-risk pests and pathogens, and allowing resources to be focused on high-risk groups.

2020 promises to be a big year for APHIS as the United Nations General Assembly has designated it as the International Year of Plant Health (IYPH), described as a once-in-a-lifetime opportunity to raise global awareness of how protecting plant health can help to end hunger, reduce poverty, protect the environment and support economic development.

The statistics speak for themselves. Plants make up 80% of our food and produce 98% of our oxygen. Worldwide trade in agricultural products has grown almost three-fold over the past decade, reaching $1.7 trillion.

> "The potential damage of major agricultural pests, such as the Mediterranean fruit fly or Asian long-horned beetle, going unchecked could run into the billions of dollars in lost production annually."

Plant pests are responsible for the loss of up 40% of global food crops and for trade losses in agricultural products exceeding $220 billion annually. At the same time, climate change threatens to reduce the quality and quantity of crops, while plant pests are appearing earlier and in places they have never been seen before.

This is at a time when agricultural production will have to rise by an estimated 60% by 2050 in order to feed a larger and generally richer population.

The IPYH will focus primarily on preventing the spread of plant pests and diseases, emphasising that, just as with human health, preventing disease is far more cost-effective than dealing with a full-blown outbreak. ■

APHIS Revises the Regulations for the Movement of Plant Pests and Biocontrol Agents.

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editorial@openaccessgovernment.org
www.openaccessgovernment.org
www.twitter.com/OpenAccessGov

Site assessment: The key to sustainable urban tree establishment

Dr Nina Bassuk, Professor at Cornell University, tells us precisely why site assessments are key to sustainable urban tree establishment

The most recent report of the United Nations Intergovernmental Panel on Climate Change (IPCC) painted a bleak picture regarding the loss of forests due to the demands of our food system- from the way we clear land for farming, transporting products and package them for consumer consumption.

One of the strategies for combatting climate change is the planting of more trees, especially in urban and marginal lands. Trees provide numerous ecosystem services, foremost among them the removal of carbon dioxide from the air and sequestering it in the wood of trees through the process of photosynthesis. However, as laudable and seemingly simple this goal is, large tree-planting programmes in urban areas often fall short of the desired intent of creating large tree canopies to mop up CO_2.

Poor tree growth inresponse to poor drainage

> "If trees are in restricted soil conditions so that the increased demand for water is not be met, tree growth or survival might, therefore, suffer."

The keys to creating a healthy tree canopy is to assess site conditions, choose the appropriate tree species, prepare and design for adequate growing space – especially below ground – and transplant the tree with a reasonable amount of early aftercare. The first step of this process is often overlooked.

A site assessment is a thorough and detailed evaluation of landscape site conditions to understand limitations or opportunities for successful plant growth and to maximise the potential for a healthy tree canopy.

With all of the best of intentions, anyone trying to plant trees or create a landscape in an urban context needs to have a firm understanding of environmental resources that allow trees to grow to their envisioned size.

Most of the places we live in, whether rural, suburban or urban have been significantly impacted by human activities, whether it is by building a house, creating roads, laying pavement for a sidewalk or a parking lot. These alterations are unquestionably more numerous in an inner-city areas than rural villages, yet they are fundamentally the same in terms of their impact.

We need to approach planting activities in human-impacted landscapes as rigorously as we engineer the urban environment into which we place them. No one would think of building a house without adhering to sound construction principles. Yet, with trees in the urban context, we seem to feel that they will take care of themselves. The urban landscape has modified and disturbed urban soils through their removal and replacement, re-grading, compaction, cutting and filling and contamination in the process of creating the built environment. All these impacts profoundly change the physical, chemical and biological nature of the soil, the very substrate that trees depend on for so many of their vital resources.

Back to basics

The most basic questions asked during a site assessment relate to the acquisition of vital resources for plant growth: water, light, oxygen and carbon dioxide, nutrients and appropriate temperatures. Where is the water coming from? Is the plant getting too little water due to soil restrictions or too much water due to lack of drainage or a high water table – or perhaps both alternating at different


Inadequate tree protection during construction


Poor drainage in a planting island

times of the year? Is the soil so dense that roots cannot grow, thereby, limiting their ability to take up water in a restricted soil volume? Are there enough available nutrients in the soil? Changes in soil pH can make nutrients more or less available to be taken up by plant roots. In urban environments because of anthropic materials incorporated into the soil, pH can vary significantly. Is there enough oxygen? All parts of the plants, shoots and roots, need oxygen. If soil drainage is impaired and all soil pores are filled with water, then oxygen will be limited and roots may die. Or if a gas leak displaces oxygen in the soil, plant roots will also suffer. Lack of oxygen in the root zone is one of the fastest killers of vegetation. Is there enough light for plant growth? Light is the driving force of photosynthesis. Many plants have evolved to take advantage of varying levels of light; however, trees, for the most part, being the tallest plants in the landscape require about six hours of sun a day during the growing season, according to estimates. Urban environments with tall buildings that cause false horizons can limit the amount of direct sunlight that trees receive.

Carbon dioxide is rarely a limiting factor in the urban environment or elsewhere. It is the essential gas necessary for the production of carbohydrates during photosynthesis. However, if plants experience water deficits, their stomata (pores that regulate water loss and carbon dioxide uptake in the leaves) close to prevent greater water loss. When this occurs carbon dioxide is prevented from entering the leaf and photosynthesis is reduced.

> "The keys to creating a healthy tree canopy is to assess site conditions, choose the appropriate tree species, prepare and design for adequate growing space – especially below ground – and transplant the tree with a reasonable amount of early aftercare. The first step of this process is often overlooked."

Are temperatures appropriate for plant growth? Urban areas are found to create 'heat islands' that can increase temperatures several degrees from the surrounding countryside. More importantly, are the microclimate effects of building facades increasing the reflected and radiating heat from car tops and asphalt that can cause trees to lose water faster or in extreme cases, directly damage leaves? If trees are in restricted soil conditions so that the increased demand for water is not be met, tree growth or survival might, therefore, suffer.

A process of establishment

With a good understanding of site conditions that promote or limit opportunities for planting, it is now possible to proceed in the plant establishment process. After site assessment, we can then ask about what plants are best adapted and support biodiversity in the site? Matching up the site constraints or opportunities to plant requirements is the important next step in successful plant establishment.

Cornell University

Dr Nina Bassuk
Professor
Urban Horticulture Institute,
School of Integrative Plant Science
Cornell University, New York, U.S.
Tel: +1 607 255 4586
nlb2@cornell.edu
https://blogs.cornell.edu/urbanhort/

Towards a climate-resilient Baltic Sea

Executive Secretary of HELCOM, Rüdiger Strempel explores the effects of climate change in the Baltic Sea and in this respect, he argues for resilience

Polaris is an impressive vessel. Built in 2016, she is the most recent addition to the sizeable fleet of ice breakers based a mere ten-minute walk away from the HELCOM Secretariat in Helsinki. But does the fact that Finland maintains a fleet of heavy-duty ships to break the sea ice in her waters mean that climate change has not reached the Baltic Sea? Unfortunately not. In fact, this region is warming faster than Earth as a whole and the sea ice cover has decreased dramatically since the middle of the 20th century. And there is more to come. Over the next 100 years, precipitation is expected to increase but the snow season will likely become shorter and the sea ice cover could decline even further. Other effects of climate change in the Baltic Sea could include higher air and water temperatures, lower salinity, decreased oxygen levels and shifts in habitats and species distribution.

In other words, climate change is adding more pressure to a fragile ecosystem already affected by a wide variety of anthropogenic impacts, such as eutrophication, pollution, overfishing and habitat loss. But HELCOM is working to tackle this issue. A priority of the current Finnish presidency of HELCOM, climate change has long been on the agenda of our organisation. Since 2007, HELCOM Ministerial Meetings have stressed that climate change will impact on the region's marine environment and should, therefore, be reflected in HELCOM policies. In 2007, HELCOM published its first thematic assessment of climate change, jointly with BALTEX. More recently, in the Declaration of the Ministerial Meeting held in Brussels, Belgium in 2018, HELCOM Ministers not only reiterated their concern about the impacts of climate change but also stressed, "the need for research and adaptive management to strengthen the resilience of the Baltic Sea in the face of climate change impacts." They also agreed, "to increase HELCOM's preparedness to respond to climate change impacts, by taking foreseen climate change impacts into account when updating the Baltic Sea Action Plan and by exploring the needs and possibilities to further adapt HELCOM's policies and recommendations 1) in line with existing objectives of protection of the marine environment and sustainable use of marine resources, also under the changing climate and 2) to maximise the capacity of the Baltic Sea ecosystem to contribute to mitigation of climate change through blue carbon storage."

"Climate change is adding more pressure to a fragile ecosystem already affected by a wide variety of anthropogenic impacts, such as eutrophication, pollution, overfishing and habitat loss."

In plain language: the Contracting Parties to HELCOM share the view that the ultimate aim of HELCOM's work on climate change should be increased resilience of the Baltic Sea system to the impacts of climate change and that a long-term, multidisciplinary approach to understanding and communicating its implications for the region's marine and coastal environment is needed. We are, therefore, working to establish HELCOM as a regional platform for policy-science dialogue on climate change, to provide robust, policy-relevant and research-based knowledge on the state, impacts and vulnerabilities of the Baltic Sea with respect to climate change and we are reviewing our policies with a view to promoting climate change adaptation.

While HELCOM's various Expert Groups and networks already strive to take account of climate change, HELCOM has now taken the topic to the next level by establishing a dedicated Network on Climate Change (EN-CLIME), jointly with Baltic Earth, a focal point for technical marine climate change information and expertise in the region. Working in the context of our State and Conservation Working Group and consisting

Rüdiger Strempel, Executive Secretary of HELCOM

of experts from both organisations, EN-CLIME cooperates closely with both other HELCOM Groups and networks and external partners. One of EN-CLIME's deliverables will be a climate change fact sheet. As a science-driven exercise, the fact sheet is intended to offer policymakers a concise and easily accessible resource providing a consensus view by the region's experts regarding relevant abiotic and biotic parameters, thus, helping to bridge the science-policy gap. The fact sheet will then continually be updated to reflect advances in science and understanding of climate change as it relates to our region. Based on the best available science, we will also broaden the scope of the Baltic Sea Action Plan, HELCOM's ambitious program of action for a healthier Baltic Sea, to encompass climate change when updating the plan for the post-2021 period.

Whether Polaris and her fellow icebreakers will still be needed 50 or 100 years from now is difficult to predict. But as we gain a better understanding of the dynamics and implications of climate change for the Baltic Sea, a clearer picture will emerge of what needs to be done to ensure a sustainable and liveable future for the Sea that defines our region and for the region as a whole.

About Rüdiger Strempel

Rüdiger Strempel has been the Executive Secretary of the Baltic Marine Environment Protection Commission (Helsinki Commission – HELCOM) since 1st August 2019. An international lawyer by training, Rüdiger looks back on many years of experience of environmental law, policy and diplomacy at the national and international levels, with a particular focus on international marine conservation. Among his previous appointments are the positions of Executive Secretary of the Agreement on the Conservation of Small Cetaceans of the Baltic, North-East Atlantic, Irish and North Seas (UNEP/ASCOBANS) and the Common Wadden Sea Secretariat (CWSS). ■

Rüdiger Strempel
Executive Secretary
Baltic Marine Environment Protection Commission – Helsinki Commission (HELCOM)
info@helcom.fi
www.helcom.fi
www.twitter.com/helcominfo

Developing research in maritime regions through innovation ecosystems

Here, the EMBRC-ERIC (European Marine Biological Resource Centre) explores the need to develop research activities by focusing on innovation ecosystems

As research develops with augmented knowledge and understandings, scientists are becoming increasingly specialised and the need for interconnectivity between a variety of diverse disciplines, such as biology, ecology, and structural and analytical chemistry, is more crucial than ever before. Communication and collaboration between scientific specialisations and companies at the regional level is essential to harness the industrial and innovation potential of Europe's maritime regions.

To support the alliances that lead to discoveries and positive impacts on our environments and ourselves, research facilities, such as European Research Infrastructures (RI), have been developed. RIs are sector specific; they provide the resources and services necessary to support and advance research and foster innovation in their given field. The European Marine Biological Resource Centre (EMBRC-ERIC) is a distributed research infrastructure that supports research in the fields of marine biology and ecology. With a network of renowned marine biological stations and institutes across Europe, EMBRC is able to provide access to marine organisms, marine ecosystems, and the facilities necessary to study them.

Marine biological resources have become major targets for the biotechnology sector, with application in fields such as aquaculture, production of food, nutraceutics, pharmaceutics and cosmetics, agronomy, and environmental health assessment. Each marine station that makes up the EMBRC consortium has connections to its region and government at local level. Biotechnology is a growing sector in many peripheral maritime regions, composed mainly of start-ups, small and medium enterprises, and only a few larger companies. This sector is thus of growing importance economically, while also being a source of high value jobs in regions that traditionally have been less developed from a technological perspective.

Click to enlarge

The multiregional, pan-European innovation ecosystems being developed by EMBRC. Within each innovation ecosystem, represented by different colors, EMBRC is working to connect public research facilities and expertise, with companies and industrial partners, supporting business parks and incubators financed by the regions. EMBRC will aim to create links between each region to establish collaborations and cooperation amongst them.

The resources that EMBRC brings to its users have the potential to enrich both industry and the regions where EMBRC facilities are located. To build up the socioeconomic potential of the maritime regions of Europe, EMBRC emphasises marine biodiversity as an

important resource for industrial applications in the health, food, energy and environment remediation sectors. Companies recognise the potential of blue technologies and bio-economy, though they may lack the tools and resources for the research that needs to be developed in the marine field. EMBRC pools resources and skills, offering access to expertise, facilities, and equipment that many SMEs cannot afford, enabling them to innovate and bring new products to market. Furthermore, as a platform for public and private collaboration, companies receive access to research activities best performed by academia which complement private sector research, accelerating the development of the blue bioeconomy.

In order to enable the regional innovation ecosystems, EMBRC is working to link researchers, companies, science parks, and company incubators around its platforms and facilities. These maritime regions which boast RIs and stimulate their use through local grants are thus beginning to act as catalysts to attract companies and investment. Such activity enables research that was not previously possible and results in higher visibility for the regions. The onsite expertise and resources offered by EMBRC are important for solving problematic bottlenecks and help develop the economy of the regions themselves. Integrating the RI at the local level increases the socio-economic impact of the RI by becoming a corner stone of local economies.

Enabling local innovation ecosystems leads to the reduction of gaps in research that exist today. Maritime regions are given a boost in their activities and, in return, provide resources to companies and research infrastructure, which in turn, increases the local innovation potential. Furthermore, the international nature of the RIs gives the potential for the mobility of knowledge across disciplines. The transfer of technology developed in the region not only has the capability to increase but also has the potential to spread across multiple regions and countries, creating new synergies, co-operations, and markets, giving the regions potentially global reach.

EMBRC
EUROPEAN MARINE BIOLOGICAL RESOURCE CENTRE

Sidonie Gras
Scientific Officer and Project Manager
Tel: +33 144 277 266
sidonie.gras@embrc.eu

Nicolas Pade
Executive Director
Tel: +33 144 278 115
nicolas.pade@embrc.eu

www.embrc.eu
www.twitter.com/EMBRC_EU

Professor Bernard Kloareg
Sorbonne University,
Coordinator of EMBRC-France,
Station biologique de Roscoff,
kloareg@sb-roscoff.fr

Ibon Cancio
Associate Professor in Cell Biology
Plentzia Marine Station (PiE-UPV/EHU)
University of the Basque Country
ibon.cancio@ehu.eus

How EU decisions affect fish, the ocean and life on earth

Rebecca Hubbard, Programme Director of the Our Fish campaign, reveals precisely how EU decisions affect fish, the ocean and life on earth

Europe's seas are home to some of the world's most productive fisheries, and the European Union (EU) is the world's largest trader of seafood products.[1] What we do with fish matters; as well as providing food and jobs for the fishing industry – fish keep our marine ecosystems functioning. Fish and marine life are the engines of our global ocean, the ocean that supplies us with every second breath drives our climate, and has absorbed 90% of the excess heat produced from accelerated climate change. You could say the ocean is the heart and lungs of the planet. So with fish populations coming under severe pressure from both climate change and overfishing, the question arises – by ending one problem, can the other be alleviated? And can we do it fast enough to make a difference?

The EU has long acknowledged its overfishing problem and member governments have committed to putting an end to it. Yet fish populations continue to be fished far beyond what scientists advise – and at the last count, some 1.7 million tonnes of 'unwanted' fish were being discarded at sea dead or dying every year – wasted.

This is clearly absurd. Back in 2013, hundreds of thousands of people around Europe thought so too and demanded an end to overfishing and discarding. Following pressure from civil society, industry and politicians, EU governments agreed to reform the Common Fisheries Policy (CFP) to end overfishing by 2015, or by 2020 at the latest.

A great deal of backslapping followed as ministers congratulated themselves on a job well done. But with commitment, action is required; 2015 is long past – and with 2020 fast approaching, EU Member States continue overfishing, treating our seas as a resource to be mined, rather than an ecosystem that supports life on our planet and a collectively-owned public good for the benefit of all citizens, now and in the future.

As a result, many EU fish populations are being fished beyond what scientists advise is sustainable. In April 2019, a report of the EU's own scientific experts[2] found that 41% of assessed populations in the Northeast Atlantic were still subject to overfishing in 2017 and 37% of stocks were still outside safe biological limits. In the Mediterranean, around 90% of fish populations are overfished.

> "It's time to sink or swim. The EU and a number of Member States have begun to acknowledge the state of the climate crisis."

At last December's AGRIFISH Council in Brussels, an annual gathering where EU fishing quotas are horse-traded during closed-door, all-night sessions, fisheries ministers agreed to quotas a whopping 300,000 tonnes above scientific advice for the North-East Atlantic in 2019 – increasing overfishing by 10% on the previous year.

Good, publicly-funded scientific advice is placed on ministers' desks, but when it comes to the crunch, long-term social, financial and ecological thinking is cast aside in favour of short term profit or political deals. The situation often worsens the following year, when scientists advise even bigger cuts to quotas – because previous decisions have worsened the health of the fish populations – creating a negative feedback loop that spirals downwards.

To make matters worse, discarding of unwanted fish at sea has not stopped; the massive waste of fish through bycatch continues and improvements in fishing selectivity and catch documentation anticipated by the reformed CFP has not eventuated. Many believe this is

largely because there is virtually no policing of fishing vessels at sea and without monitoring and enforcement, the rules are simply being ignored. With stories of widespread illegal and unreported catches emerging, Our Fish has launched Fishyleaks.eu, to provide a secure and anonymous website for reporting infringements.

Does it have to be this way? Of course not. Will it take a long time to change? No. During two EU Council meetings of two days each and one week of negotiations with Norway, the EU sets its annual fishing limits. Member States can end overfishing by 2020 (as law demands), by simply following scientific advice. And they can enforce the ban on discards by introducing Remote Electronic Monitoring on fishing vessels (CCTV in working areas) to verify that what they are catching and reporting, reflects the fish that are being brought ashore.

Is overfishing the only threat to the ocean? Certainly not. But besides the rapidly worsening impacts of climate change, it is still considered the greatest. Can removing one help the other? A new paper from scientists at the University of British Columbia, released on 2nd September and commissioned by Our Fish, finds that one of the clearest pathways to building ocean resilience in the face of climate change is to end overfishing.

The paper finds that overfishing severely weakens the health of the ocean. So when climate change hits, the ability of the ocean (and its wildlife and fish populations) to withstand that extra impact, is severely undermined. But scientists have found that by removing the pressure of overfishing, fish species have a drastically increased chance of survival. Combined with the fact that fish help sink carbon in the ocean and reducing extra boats will achieve a more profitable and sustainable carrying capacity, it means ending overfishing will also capture more carbon and reduce emissions.[3]

It's time to sink or swim. The EU and a number of Member States have begun to acknowledge the state of the climate crisis. They are debating a target of net-zero emissions by 2050 and talking about new Green Deals which will prioritise action that pulls back the runaway climate change train and saves nature for our children.

But if the EU is going to do this, it needs to put the ocean at the heart of any climate action plan – because the ocean is the heart and lungs of the planet. And we are going to need many tools and strategies, including those that can be practically delivered immediately. Not only does ending overfishing rebuild marine life and deliver on EU fisheries law, but it is also instrumental in bolstering ocean resilience in the face of dangerous climate change. Ending overfishing is emergency climate action and it's time the EU slams on the brakes. ■

Rebecca Hubbard

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Rebecca Hubbard
Programme Director of the Our Fish campaign
Tel: +34 657 669 425
rebecca@our.fish
https://our.fish/
www.twitter.com/our_fish

Full utilisation of the catch of pelagic fish: Opportunities and challenges

Turid Rustad, Professor NTNU in Norway, explains the opportunities and challenges when it comes to the full utilisation of the catch of pelagic fish to meet the increasing demand for food

The world population is increasing and is expected to reach 10 billion by 2055. This leads to an increased demand for food, especially high-value proteins and lipids. Today, only 5% of protein consumed comes from the ocean, while about 17% of the animal protein is supplied by fish and marine food. To increase the availability of high-value protein, there is a need to increase the amount of food coming from the ocean. Since most fish stocks are already fully exploited or overexploited, we cannot expect to increase the amount of captured fish. One way to increase the amount of food from the ocean is to improve the utilisation of the catch. Up to 50% of the fish is commonly discarded when preparing seafood industrially. Others claim that seafood processing discards and by-products make up around 75% of the total weight of the catch.

Today, the potential of rest raw material is not fully exploited. There is no single definition of marine by-products. Usually, we talk about viscera, heads, cut-offs, bone, skin and fish that is damaged or unsuitable for human consumption (or further processing) and bycatch. In Norway, 'by-products' are defined as products that are not regarded as ordinary saleable products (fillet, round, eviscerated or beheaded fish), but which can be recycled after treatment. 'Waste' includes products that cannot be used for feed or value-added products, but which have to be composted, burned or destroyed. Marine by-products intended for human consumption are not included in this definition and the term rest raw material should, therefore, be used.

Increasing demand for more convenient products – fillets, ready to heat/ready to cook meals leads to a higher proportion of fish that is being processed before sale. The trend in the Norwegian pelagic industry is towards more processing instead of exporting the fish as frozen whole fish. In 2018, Norway generated approximately 205,000 tonnes of rest raw material from the pelagic industry out of a total catch of 1,296,000 tonnes (Richardsen et al., 2018). However, a large part of the mackerel is still exported as round frozen fish.

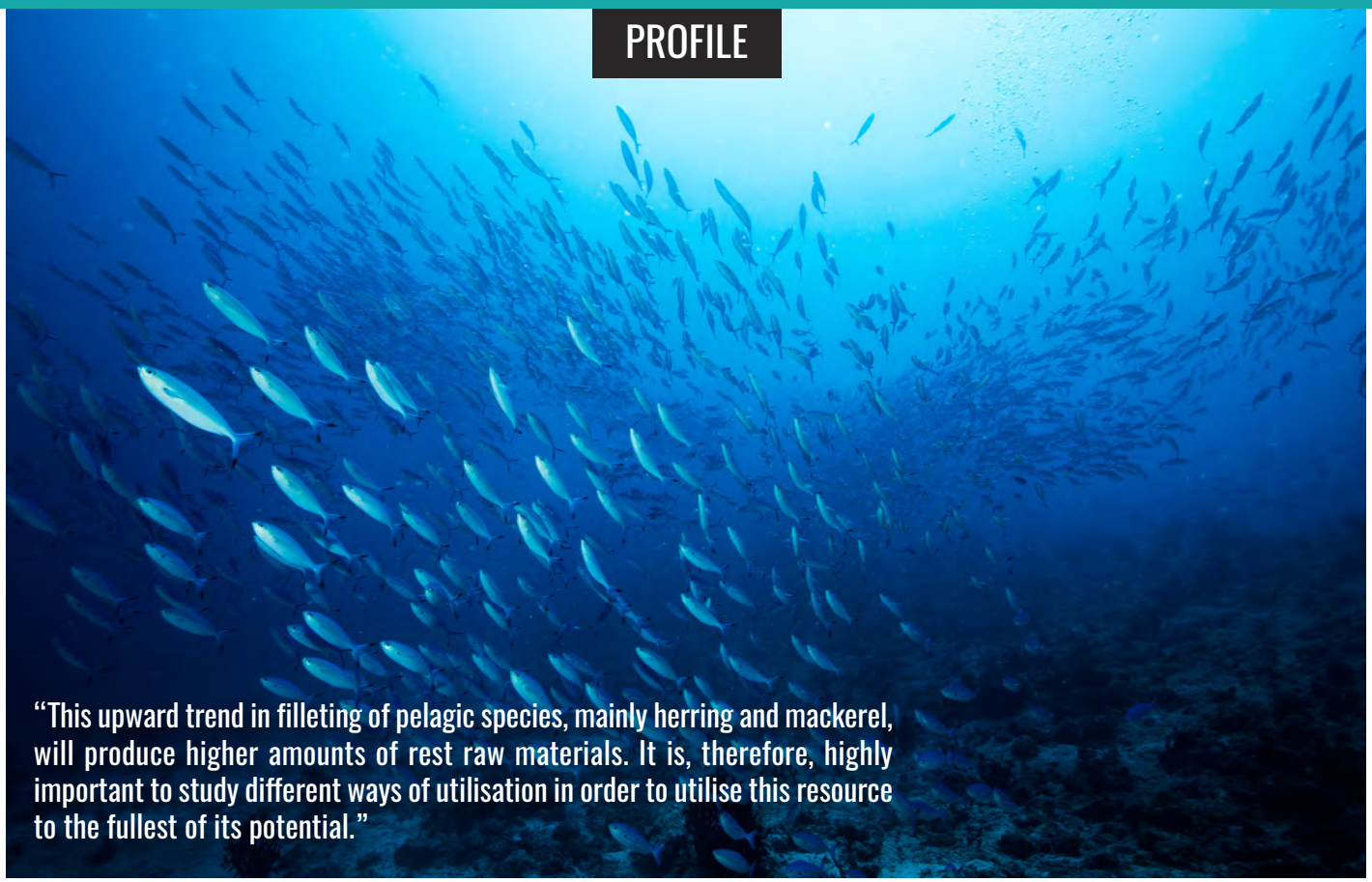
The rest raw material from pelagic fish contains high amounts of beneficial and healthy long-chain omega-3 fatty acids, high-quality protein and other valuable components such as nucleic acids, calcium and phosphorus. The rest raw material, therefore, has high potential in the production of high-quality bio-molecules with various applications within the food, pharmaceutical and cosmetic industries.

This upward trend in filleting of pelagic species, mainly herring and mackerel, will produce higher amounts of rest raw materials. It is, therefore, highly important to study different ways of utilisation in order to utilise this resource to the fullest of its potential. The main challenges with the utilisation of rest raw material from pelagic fish are the high-fat content and the high content of dark muscle.

The quality of the raw materials and retaining the quality of the rest raw materials is one of the key factors for successful utilisation where fresh raw material gives better products. Rest raw material can be divided into two main groups: fractions with a high concentration of different endogenous enzymes (fractions containing viscera or blood) and more stable fractions such as heads, skin and bones. The first group is especially susceptible to fast degradation even at low storage temperatures.

In Norway, the main part of rest raw material from pelagic fish is used to produce fish meal and oil. The fish oil is currently the main product generated from the rest raw material of fatty fish and has traditionally been produced by cooking and pressing followed by centrifugal separation. However, the high temperatures used may be hard on the sensitive marine lipids, leading to faster degradation and oxidation. Carvajal et al. (2015) showed that high-quality herring oil could be extracted from fresh herring rest raw material with more gentle heating (60-70°C).

Different types of protein fractions can be produced from fish rest raw



"This upward trend in filleting of pelagic species, mainly herring and mackerel, will produce higher amounts of rest raw materials. It is, therefore, highly important to study different ways of utilisation in order to utilise this resource to the fullest of its potential."

material. Flesh from backbones and cut-offs can be used for the production of fish mince and surimi. Recovery of proteins with good functional properties from rest raw material and small fatty pelagic fishes has been difficult due to the high content of heme proteins and lipids, resulting in pressure lowering and oxidation problems. The pH shift method where the proteins are solubilized at either high or low pH and then precipitated at isoelectric pH has been shown to give good yields and be a good method for removal of heme and lipids (Abdollahi and Undeland, 2018).

Enzymatic hydrolysis is a processing method for recovering both fish oil and protein from fish rest raw materials. Fish protein hydrolysates (FPH) have good functional properties (water-holding, texture, gelling, foaming and emulsification) as well as high nutritional value. Hydrolysates from pelagic rest raw material have also been shown to have bioactive properties such as antioxidant activity and blood pressure-lowering effect.

Some of the challenges related to producing protein hydrolysates are related to taste. The production of tasteless hydrolysates from pelagics has been studied in several projects. Both the bitter peptides and the lipids and lipid oxidation products in the hydrolysate fractions have been shown to contribute towards the unwanted bitter taste.

The current primary use of pelagic rest raw materials is towards low-end products – for production of fish meal used for aquaculture feed and pet food. A shift towards the production of higher-quality products for human consumption will generate a higher value as well as resulting in higher efficiency in the bio-economy.

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NTNU

Turid Rustad
Professor
NTNU
Tel: +47 7359 4066
turid.rustad@ntnu.no

Marine Conservation Zones: Protecting our seas

Joan Edwards, Director of Living Seas at The Wildlife Trusts shares her thoughts on the news that the UK government announced an important new wave of marine protection in the form of 41 new Marine Conservation Zones (MCZs)

Earlier this year, the UK government announced an important new wave of marine protection in the form of 41 new Marine Conservation Zones (MCZs) in English and Northern Irish waters. It marks the culmination of decades of campaigning by The Wildlife Trusts and a highly significant moment in the struggle to get the legislation and political will to deliver an ecologically coherent network of protected areas at sea. This network of protected areas will ultimately allow our small corner of the blue planet to recover.

It has not been easy, however. When I began my career in marine conservation thirty years ago our seas were under tremendous pressure from a range of damaging activities including over-fishing, oil exploration and pollution. What's more, there were only three Marine Nature Reserves in the whole of the UK and a handful of Voluntary Marine Conservation Areas.

We surveyed the myriad sea-bed types and multitude of beauties, curiosities and downright breath-taking marine wildlife around our shores – and talked to anyone who'd listen about the wonders of our seas. Yet, at the same time as we gathered public support to protect the wonders of our marine environment, cod nearly became commercially extinct in the North Sea, hundreds of dolphins were being washed-up dead on our shores and in the 1980s and 90s, horse mussel communities were destroyed in one of our few marine nature reserves by dredging for queenies.

It was time for change. In 2002, we called for a marine bill which would allow us to manage and protect our marine environment. The legislation at that time was out-dated, not fit-for-purpose and, most importantly, prevented us designating marine protected areas and managing our inshore fisheries sustainably. Then we rallied our members and supporters – a staggering 250,000 people signed silver scales during our Petition Fish campaign to Lobby Westminster for action. We were all thrilled when, in 2009, the Marine Act was passed which gave us the legal tools to designate a network of protected areas and the power to ensure that the wider seas were managed in a sustainable way.

In the following years, a million people took part in a process to identify where these zones should be located and what they should protect and ten years on, I am over the moon that the third phase of Marine Conservation Zones (MCZs) have been announced. This historic move will help protect our seas and the wildlife which live there, constituting the third of three phases promised by the Government in order to fulfil the remit of the Marine and Coastal Access Act bringing the total number of MCZ designations to 91. It marks a turning point for the future of our seas. A fitting testament to the huge amount of effort put into marine campaigning by so many, and a recognition that people who care about the hidden depths, the submerged landscapes, the last truly wild place in the UK – have been listened to.

The 41 new MCZs are special places and include cold water corals, forests of sea fans, rocky canyons and sandbanks – an astonishingly varied range of sub-merged landscapes and habitats which support the stunning diversity of marine life. They include Bembridge MCZ which is very unusual because it is home to both species of native seahorse, Solway Firth

Joan Edwards, Director of Living Seas

MCZ whose sand banks are resting places for seals, and Holderness Offshore MCZ which is important home for growing crabs and lobsters.

However, designation of these sites, referred to by some as 'lines on maps' is only the first step. Now we must focus on ensuring that all our Marine Protected Areas (Marine Conservation Zones and Special Areas of Conservation) are managed effectively – and the most damaging activities are prohibited to allow our amazing marine environment to recover. We don't know exactly what recovery will look like, but we do know that in the past when destructive activities were removed from areas such as Lyme Bay, the seabed's plants and animals showed incredible resilience; even slow-growing and sensitive species such as sea fans and ross corals can reappear after just a few years.

So, to sum up, there's much to celebrate... but the job isn't finished. We need to ensure our Marine Protected Areas are well-managed so that these zones will contribute towards a network of areas which is urgently needed to ensure a healthy future for our seas.

Joan Edwards trained as a marine biologist at Bangor University and joined The Wildlife Trusts as their first marine conservation officer in 1987. She was the first conservation member of a Sea Fisheries Committee in 1992. Joan was made aware of the damage to Lyme Bay reefs by local fisherman in 1994 and was behind the government's landmark announcement of the Lyme Bay protected area in 2007. She was instrumental in the development of the Marine and Coastal Access Act and led the NGOs' collective campaign to get it through parliament. Most recently Joan is on the review panel of Highly Protected Marine Areas in English Waters. ■

Joan Edwards
Director of Living Seas
The Wildlife Trusts
enquiry@wildlifetrusts.org
www.wildlifetrusts.org
www.twitter.com/WildlifeTrusts/

Mobility of iodine species in the environment and solid waste

Peter H. Santschi, Professor at Texas A&M University at Galveston, TX, shares his expert thoughts on the mobility of iodine species in the environment and solid waste

In order to contain long-lived radioactive iodine (16 Mio year half-life of ^{129}I) from nuclear waste, various methods have been employed, with various success. Iodine-129 is one of three key risk drivers at several U.S. Department of Energy waste management sites. Natural organic matter (NOM) is thought to play important roles in immobilisation of aqueous iodide (I^-) and iodate (IO_3^-) in the environment by forming organo-iodine (org-I), but molecular interactions between NOM and iodine species are still poorly understood. When appropriate analytical techniques were applied to determine the chemical speciation of iodine in aquatic systems, regardless of surface or groundwater, fresh or ocean water, solution in soils, sediments or cement systems, an almost equal proportion of iodide, iodate and organo-iodine were found (reviewed in Kaplan et al., 2014; Yeager et al., 2017), even in the presence of minimal amounts of natural organic matter (NOM). All three species are always found simultaneously, irrespective of where one measures it: arid, humid, marine systems, U.S. or Japan (Xu et al., 2016).

Therefore, to contain all iodine species at DOE waste sites once they have reached the natural environment, or to effectively remove all radioiodine species from waste streams at the same time remains a challenge. Often, containing at least one of these species, often org-I, is problematic. Organo-iodine species that are found in the environment in the form of humic acids, which are part of the natural organic matter (NOM) matrix, can be either mobile or immobile, depending on conditions. Thus, a better understanding of the molecular binding of the I to the organic core is required to solve this problem. A recent study by Li et al (2019b) aimed to improve our molecular-level understanding of NOM-iodine interactions and enzymatically-mediated iodination reactions in aqueous media. These authors investigated the mechanisms iodine and carbon species are bound to three different humic acid (HA)-I systems using I K-edge XANES and EXAFS and C K-edge XANES spectroscopy: 1) I- in the presence of the laccase enzyme and a mediator (2,2'-azino-bis(3-ethylbenzothiazoline-6-sulfonic acid, ABTS) at pH 4 buffer, 2) I- in the presence of lactoperoxidase and H_2O_2 in pH 7 buffer, 3) IO_3^- at pH 3 groundwater. Results showed that in both the oxidase and peroxidase systems, I^- is oxidized to I_2 or hypoiodide (HOI), but the laccase-ABTS mediator system was the most effective at oxidizing I^- to I_2 or HOI, so that I^- uptake by HA increased up to 13.5 mg/g of humic acid. IO_3^- was abiotically reduced to I_2 or HOI. Pathways for HA iodination include covalent modification of aromatic-type rings by I_2/HOI or iodine incorporation into newly formed benzoquinone species arising from oxidation of phenolic C species. However, org.-I species can still become mobile in the environment under certain conditions, despite the fact that most of them are contained in the soil. Soil and groundwater contamination are ubiquitous at the U.S. Department of Energy waste management sites and, thus, it is imperative that technologies are developed to contain all iodine species that have already escaped to the environment.

> "All in all, these results show that it is still challenging to contain all radioiodine species in solid waste. This has important implications for estimated risk from nuclear waste disposal."

Silver (Ag) based technologies are amongst the most common approaches to removing radioiodine from aqueous waste streams. As a result, a large worldwide inventory of radioactive AgI waste presently exists, which must be stabilised and requires disposal. Recently, Li et al (2019a) examined the efficacy of silver-impregnated granular activated carbon (Ag-GAC) to remove I^-, iodate IO_3^- and org-I from cementitious leachate. In addition, cementitious materials containing three different aqueous iodine species, I^-, IO_3^-, or org-I loaded Ag-GAC were characterised by iodine K-edge

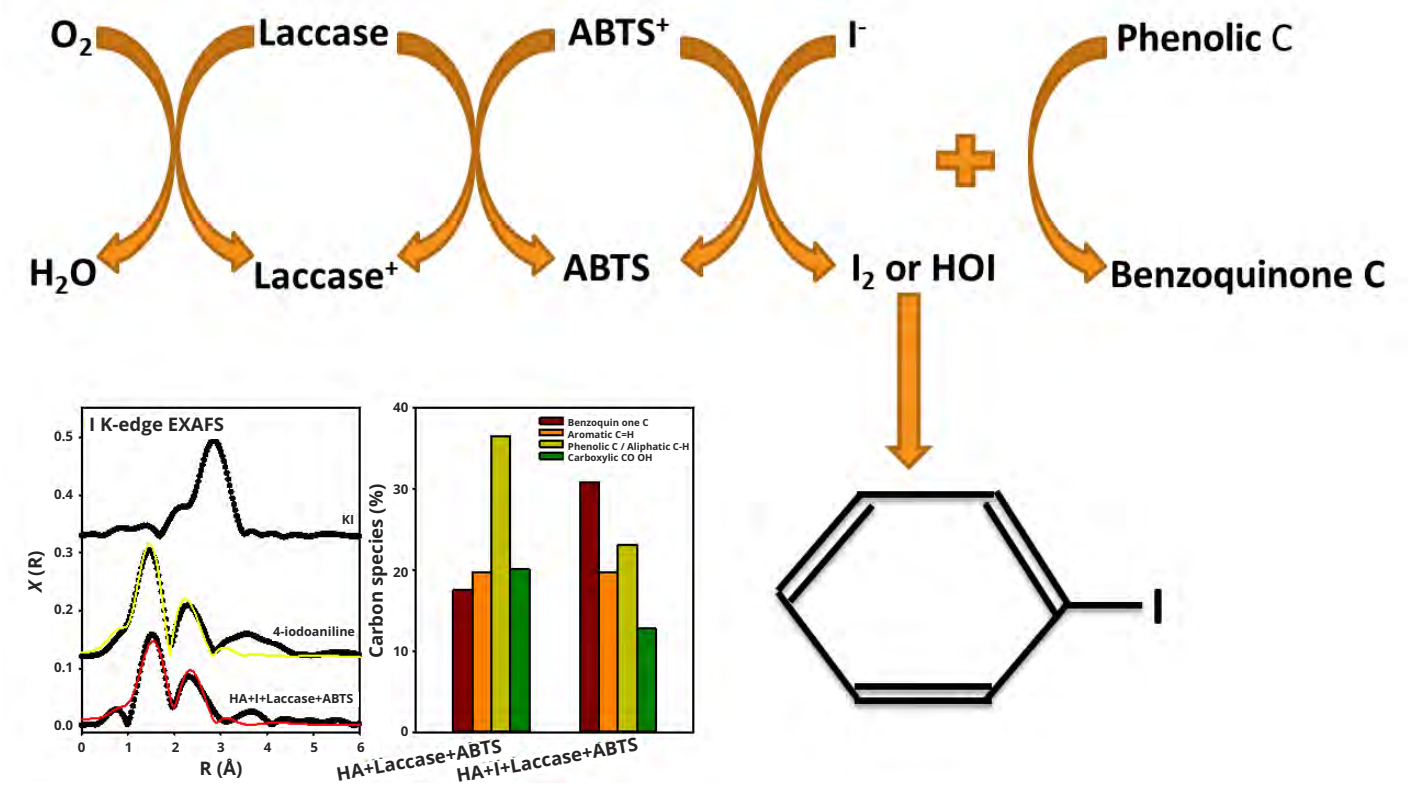

Figure 1. A simplified scheme for HA iodination in the presence of laccase enzyme and ABTS ABTS mediator system that significantly enhances the iodination process for aromatic molecules

XANES and EXAFS to provide insight into iodine stability and speciation in these waste forms. The results showed that Ag-GAC was very effective at removing I- and org-I, but ineffective for IO_3^-, from slag-free grout leachate under oxic conditions. I^- or org-I removal was due to the formation of insoluble AgI(s) or Ag-org-I on Ag-GAC. When I^-loaded Ag-GAC material was cured with slag-free and slag grouts, the I^- was released from AgI(s) to form a hydrated I^- species. Conversely, when org-I loaded Ag-GAC material was cured in the two-grout formulations, no change was observed in the iodine speciation, indicating the org-I species remained bound to the Ag. Because little IO_3^- was bound to the Ag-GAC, it was not detectable in the grout. It was concluded that the grout formulation and iodine speciation in the waste stream can significantly influence the effectiveness of the long-term disposal of radioiodine associated with Ag-GAC in grout waste. All in all, these results show that it is still challenging to contain all radioiodine species in solid waste. This has important implications for estimated risk from nuclear waste disposal.

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TEXAS A&M UNIVERSITY
GALVESTON CAMPUS.

Peter H. Santschi
Professor
Texas A&M University at Galveston, TX
Tel: +1 409 539 1007
santschi@tamug.edu
http://loer.tamug.edu/people/Santschi/index.html

Marine geoscience research and UK aggregates

It is often said that we know more about the surface of the moon or Mars than the ocean floor but marine geoscience research is enabling a better understanding of some of the biggest issues we face, including climate change, coastal erosion and renewable energy

Marine geoscience research helps to maximise marine resources, such as oil, gas, marine aggregates, aquaculture and fishing, while also contributing to the conservation of biodiversity and marine archaeology.

The British Geological Survey began a programme to start mapping the United Kingdom Continental Shelf (UKCS) in 1966, starting with inshore areas and moving progressively into deeper and more exposed waters. At the time, the government's commitment to investigate national offshore resources had not been attempted at such a scale by any other country.

The offshore survey of the regional mapping programme took over 20 years until in 1986, the United Kingdom became the first country to completely map its continental shelf.

During this work, BGS geologists produced a series of reports, scientific papers and 1:250,000 scale maps showing the distribution of sediments on the seabed, the Quaternary geology of sediments deposited over millions of years and the underlying bedrock.

The regional mapping of the UKCS led to interest in further surveys in deep-water areas to the west of the UK, backed by industry funding. Carrying out this work required the development of new offshore survey equipment, including a one-metre oriented drill specifically designed to recover samples for use in palaeomagnetic studies, autonomous battery-operated vibrocoring systems and a rockdrill capable of coring up to 55 metres below the sea floor in water depths up to 4,000 metres.

Today, the BGS Marine Geology and Operations team, based at the Lyell Centre 2 near Edinburgh, undertakes both scientific and commercial projects in UK-designated waters and internationally, from polar to tropical environments.

It has expertise in coring and drilling operations, geophysical surveys, seabed sampling and loch, lake and inshore surveys using the BGS survey vessel, The White Ribbon.

It is also the European operations facility of the International Ocean Discovery Programme, undertaking the management, logistics, planning and contracts for Mission-Specific Platform expeditions.

Marine aggregates

Marine aggregates are naturally occurring sands and gravels with the shape, strength and other physical characteristics generally identical to high quality land-based aggregates.

They are mainly used in the manufacture of concrete, which accounts for nearly 80% of marine aggregates landed for construction purposes. By comparison, 60% of land-won sand and gravel production and 16% of crushed rock is sold as concrete aggregate.

Marine aggregates are also widely used in the production of asphalt, masonry and paving blocks, sports pitches, golf courses, drainage and fill materials, horticulture products and steel.

The UK has one of the largest dredging industries in the world. Over 20 million tonnes of marine sand and

gravel are extracted from more than 65 licensed areas around the coast of England and Wales every year. No marine-dredged sand and gravel is landed in Scotland.

Approximately 17% of the sand and gravel used in England and Wales is now supplied by the marine aggregates industry. The sector also contributes to the economy through exports to the continent.

However, activities on the UKCS have undergone major changes due alternations to the planning regime introduced by the Marine & Coastal Access Act 2009 and the Marine (Scotland) Act 2010, as well as increased pressure on the seabed from new developments, such as renewable energy.

"The UK has one of the largest dredging industries in the world. Over 20 million tonnes of marine sand and gravel are extracted from more than 65 licensed areas around the coast of England and Wales every year. No marine-dredged sand and gravel is landed in Scotland."

The Marine & Coastal Access Act, which covers England and Wales, established the Marine Management Organisation to licence, regulate and plan marine activities to ensure they are carried out in a sustainable way. It also introduced Marine Plan areas with an associated planning authority responsible for considering the social and economic needs of coastal communities and how to accommodate different activities, ranging from seaborne imports or building turbines to leisure and tourism, while protecting habitat. All areas are required to have a plan by 2021.

Similarly, the Marine (Scotland) Act introduced a strategic marine planning system designed to balance the competing demands on the seas while protecting the marine environment. Following on from this, the Scottish Government produced a National Marine Plan and subsequently Regional Marine Plans to consider the social, economic and environmental aspects of development.

As a result of these changes, the Crown Estate, as the owner of mineral rights in UK waters, wanted to improve its understanding of marine mineral resources and so commissioned the BGS to produce maps of sand and gravel, as well as coal, metallic minerals and evaporites.

Five 1:250,000 scale maps were produced covering:

- East Inshore and East Offshore Marine Plan Areas, Southern North Sea.
- The English Channel and Thames Estuary.
- Welsh Waters and the Irish Sea.
- Scottish Waters and the Central North Sea.
- A summary map for the United Kingdom Continental Shelf.

The maps provide spatial data for strategic planning and accessible information to assist in the protection of these non-renewable resources.

Future challenges

Looking ahead, an ever-increasing demand for housing and infrastructure will drive demand for construction aggregates. Meanwhile, climate change means demand for large volumes of marine-dredged sand and gravel for coastal protection, replenishing eroding beaches and improving inland drainage infrastructure.

The sector has entered a new phase, with geoscience research-backed planning and licensing supporting a more strategic, sustainable and long-term approach to the management of marine areas. ■

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Achieving zero-carbon with deep-sea minerals

Professor Bramley J Murton, Associate Head of Marine Geosciences from National Oceanography Centre, discusses if deep-sea minerals can meet the zero-carbon challenge, in this article

It is clear the world is facing a shortfall in the supply of critical elements to reach any meaningful target for net-zero carbon emissions this century. However, the deep ocean floor hosts billions of tonnes of metalliferous mineral deposits that may hold the solution.

With the recognition and acceptance that fossil carbon-based fuels are environmentally unsustainable sources of energy, causing uncontrolled and adverse effects on the global climate, the world is demanding their replacement with renewable energy sources to achieve a zero-net carbon future for humankind in the second half of the 21st Century [1].

The ambition to replace fossil carbon-based energy sources with renewables will be accompanied by a huge increase in demand for metals like copper, nickel, zinc, and elements critical to enabling renewable energy generation.

Many of these elements are relatively scarce or restricted to very few areas of the globe and include: cobalt and lithium (used in batteries for electric vehicles); tellurium (used in cadmium-telluride thin-film, photovoltaic electrical energy generation); neodymium and dysprosium (used for permanent magnets in wind-turbines and electric motors); heavy rare earth elements (used in electronics), and platinum group elements (used in fuel cells and hydrogen catalysers).

This demand is illustrated by the resources needed to electrify the world's estimated 2 billion private cars. Compared with today's global metal production [2], the best-case scenario requires 126 years' of cobalt, 62 years' of neodymium, 45 years' of lithium, and 31 years' of copper. To power these by wind turbines requires 20 years of neodymium and dysprosium [3] or, using CdTe-type photovoltaic solar energy [4], 2000 years' of tellurium supply

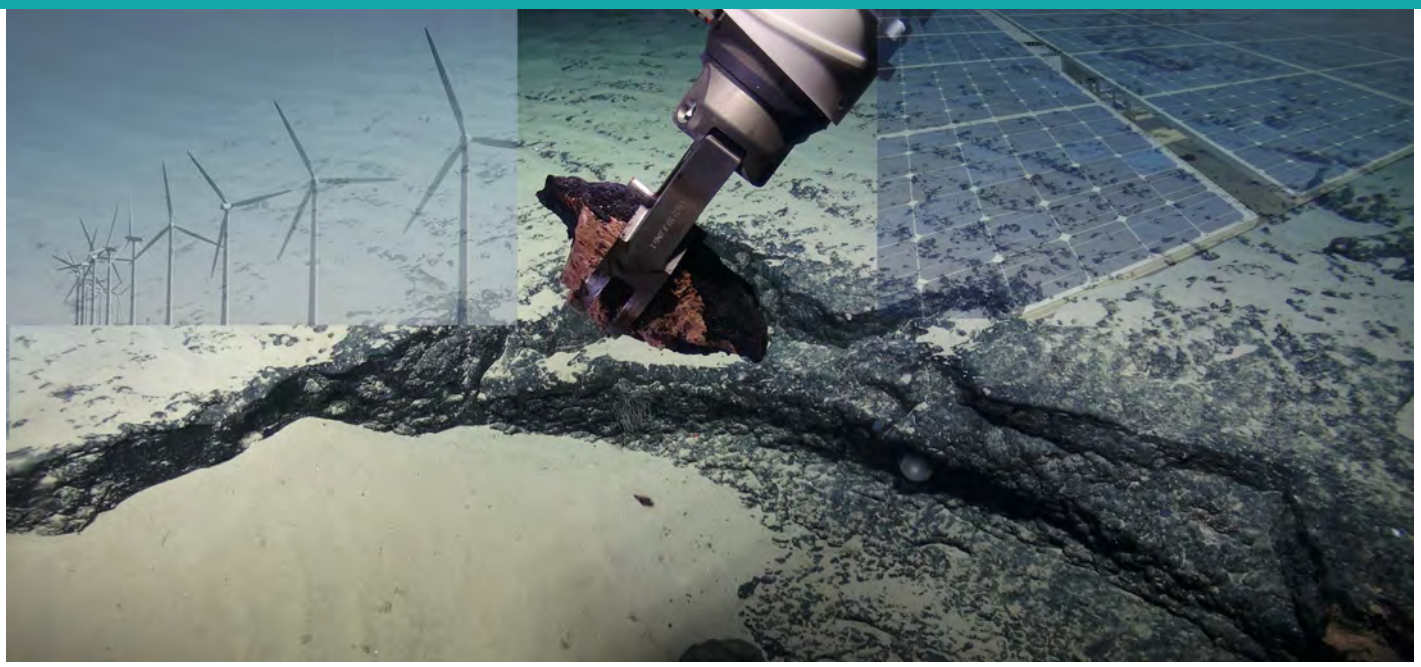
Potential

Deep-sea minerals are rich in these critical elements. There are three main types of deposit. Ferromanganese nodules are iron-manganese oxide-oxyhydroxide concretions, rich in nickel, copper, titanium, cobalt and heavy rare earth elements, and are found on the deep ocean floor between 4,000-6,500 m. The best known is the Clarion-Clipperton Zone (CCZ), between the west coast of Mexico and Hawaii, and has about 21-30 billion tonnes. The Peru Basin has about ~6-9 billion tonnes while the Penrhyn Basin, located near the Cook Islands, has an estimated 5-7 billion tonnes of nodules with a resource potential of ~21 million tonnes of cobalt (i.e. 210 years' worth of global land-based production).

In the Indian ocean, nodule fields are less valuable, containing low average abundances ~5 kg/m2. Worldwide, ferromanganese nodules present an enormous source of metals, with 10 times more manganese, 6 times more cobalt, 4 times more tellurium and yttrium, 3.5 times more nickel, and a third more copper compared with land-based reserves [5].

Cobalt-rich crusts are another type of iron-manganese oxide-oxyhydroxides accretion, up to 25 cm thick, formed on rocky substrates such as seamounts and underwater ridges. They are rich in cobalt (0.5-1.2%) and other critical elements such as tellurium, platinum, rare earths, titanium, thallium and nickel [6]. These crusts occur throughout the global ocean, at all depths below 700 m, but are thickest on the oldest areas such as the prime crust zone of the northwest Pacific. They contain more than half the nickel, a fifth of the titanium, over 3 times the yttrium (and other rare earth elements), 7 times the cobalt, 23 times the tellurium, and 3000 times the thallium compared with land-based reserves [5].

Seafloor massive sulphides and their metalliferous sediments are the product of intense seafloor volcanic activity and form rapidly from high-temperature (up to 415°C) hydrothermal fluids (black-smokers). They form 100-300 m diameter deposits, on and below the seafloor, at depths from 1000 to 5000 m, in all oceans. They are primarily rich in iron (up to 32%), zinc (up to 17%), copper (up to 13%), gold (up to 13 ppm), silver (up to 2000 ppm) and have elevated concentra-



tions of selenium, cobalt, bismuth, cadmium, gallium, germanium, antimony, tellurium, thallium and indium [7]. While current estimates suggest about 600 million tonnes of accessible seafloor massive sulphide [8], hydrothermally inactive deposits may be 10 times more abundant than active ones with between 3 and 5 times more sulphide under the seafloor than above it [9], hosting 20 to 30 billion tonnes of ore worldwide.

Challenges

There are three major challenges facing the nascent deep-sea mining industry. First is the uncertainty around the regulations that the United Nations International Seabed Authority is drafting, and due in 2020. Second, there remains considerable technological challenge to deep-sea mineral exploration and mining, thousands of metres below the surface and thousands of kilometres offshore. Thirdly, protecting the environment is key to gaining social license, for which much needs to be done to identify potential harm and how to mitigate it.

Future options

Although ferromanganese nodules receive the greatest attention, cobalt-rich crusts are the most enriched, host the largest global resources of cobalt and tellurium, and are closest to land. This makes them the most viable deep-sea minerals to be exploited. There remains, however, a deep-sea resource barely mentioned, yet is truly sustainable and with the greatest potential to achieve a zero-net carbon future. High-temperature geothermal energy, of the type driving hydrothermal vents, has the potential to generate terawatts of unlimited power. Tapping this, using offshore oil and gas production technology, and converting it to storable, transportable fuel like hydrogen, poses an as yet unexplored and unlimited resource in renewable energy.

Without deep-sea minerals and, probably, geothermal energy, there is unlikely to be a net zero-carbon economy. This may not be a welcome message, yet, because the alternatives remain elusive, urgent research and development in this space is required now.

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National Oceanography Centre
NATURAL ENVIRONMENT RESEARCH COUNCIL

Prof Bramley J Murton
Associate Head of Marine Geosciences
National Oceanography Centre
Tel: +44 (0)2380 596543
bramley.murton@noc.ac.uk
www.noc.ac.uk/people/bjm
www.twitter.com/NOCnews

The EU and Japan: Cooperation on innovation in the clean energy transition and climate action

Mauro Petriccione, Directorate-General for Climate Action at the European Commission, discusses how the EU and Japan are cooperating on innovation in the clean energy transition and climate action

Writing as not only the current Director-General for Climate Action but also as the former European Union (EU) chief negotiator of the Economic Partnership Agreement (EPA) with Japan, I am very positive about the statement of 15th June this year made by the EU and Japan. The EU and Japan agree to strengthen bilateral energy dialogues and cooperation on innovation in the clean energy transition and climate action, and this is an example of the EU's continued efforts to ensure that fighting climate change is at the heart of our international cooperation.

"Working together gives us a much stronger voice on the world stage in demanding ambitious reductions in greenhouse gas emissions and ensuring the protection of vital carbon sinks such as the Amazon Rainforest. This strengthens our credibility as global leaders and allows us to make the case for other international partners to do their part as well."

The EU and Japan increasingly share a common understanding of the need to address the threat of climate change. A more coordinated approach between the EU and Japan would have benefits for all, as we defend multilateral solutions and promote sustainable, inclusive and climate-resilient economies to the benefit of our businesses and societies.

The EU and Japan are leading technological innovators and strengthened cooperation will create more opportunities for joint projects to advance the clean energy transition. When we share a common view of both the scale of the challenge, as well as the possible solutions, we are much better equipped to advocate for the actions that are vital to achieving our goals under the Paris Agreement.

Mauro Petriccione

Working together gives us a much stronger voice on the world stage in demanding ambitious reductions in greenhouse gas emissions and ensuring the protection of vital carbon sinks such as the Amazon Rainforest. This strengthens our credibility as global leaders and allows us to make the case for other international partners to do their part as well.

The importance of strengthening existing international cooperation cannot be underestimated. Major global challenges such as population growth, resource scarcity and food supply insecurity are all exacerbated by climate change. If we are to continue delivering economic growth and enable our citizens to enjoy high standards of living, we must ensure sustainability across all our economic activities and sectors around the world.

In a globalised economy, this means placing sustainability concerns at the heart of our own actions whilst encouraging our partners to do the same. As such, strengthened cooperation increases our ability to deliver on our commitments and ensure a more sustainable global economy that leaves no one behind.

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Looking closer to home, after the EU had adopted all the legislation needed to achieve its ambitious 2030 climate and energy objectives, the European Commission in 2018 put forward a strategic vision for a prosperous, modern, competitive and climate-neutral economy – Communication 'A Clean Planet for All', which is the basis for European Commission calls for the EU to become climate-neutral by 2050. Achieving this ambitious goal requires making smart investment decisions now and ensuring that technological solutions are in place in good time to ensure dramatic reductions in greenhouse gas emissions over the coming decades. EU climate policy is a continuous process and the upcoming European Commission, building on all this, has already set out its course, re-affirming that the EU should endorse the objective of climate neutrality by 2050 and proposing to raise the ambition for 2030.

Taking these actions will benefit the EU in any case but acting alongside global partners like Japan in a coordinated way will bring economies of scale and significantly reduce the costs of the transition for all. More importantly, it will make it easier and more likely for other nations to deliver their share of reductions in global greenhouse gas emissions, which is indispensable to limiting global temperature rise to 1.5°C. ■

Mauro Petriccione
Directorate-General for Climate Action
European Commission
https://ec.europa.eu/clima
www.twitter.com/EUClimateAction
www.facebook.com/EUClimateAction

A priority for Europe: Energy Union and climate change

Energy Union and climate as a priority of the European Commission are placed under the spotlight here by Open Access Government

Energy Union and climate change are a very high priority for the European Commission. They believe that in building an Energy Union, all Europe's energy supply will be viable, safe and accessible to all. This is an approach that boosts the economy and attracts investments that have the potential to open up new job opportunities. (1)

This article will look at the work of some key figures in this part of the European Commission, with a focus on Maroš Šefčovič, Vice-President, Energy Union, who will soon move onto his new role of Interinstitutional Relations and Foresight as part of the 2019-2024 Commission. One of his responsibilities today is leading the project team Energy Union and another is improving energy efficiency, amongst many more. (2)

In recent news, we learn that the European Commission adopted a Communication reaffirming the commitment of the EU to accelerate climate ambition. Commenting on this in more detail in the lead up to the Climate Action Summit by the United Nations Secretary-General in New York, Maroš Šefčovič provided further comments. However, by the time you read this, it will have already taken place (on 23rd September 2019) but the comments are, nevertheless, very insightful.

"With the Paris Agreement, for the first time all parties committed to reduce emissions. Now we must make sure these reductions are timely enough to avoid the worst of the climate crisis. The European Union will bring to New York the fruit of our work on the Energy Union: a realistic perspective of a climate-neutral Europe by 2050, backed by ambitious policies set in binding legislation. The EU has ensured that all sectors contribute to the transition. At the Climate Action Summit, we hope our plans will inspire other countries, and we hope to be inspired. Our message is simple: Europe delivers." (3)

Energy Union governance ensures that the 2030 Climate and Energy targets are reached. Maroš Šefčovič said in July that he has the ambition to provide the financial sector and businesses, "with the necessary clarity and predictably to spur clean energy investment across Europe." He added that the development of renewable energy generation required a move from a power-centric to decentralised models (with households/communities producing, storing, consuming and selling their electricity). He also explained that raw materials are part of carbon-neutral renewable energy technologies (photovoltaic and wind) and that they are vital for sustainable mobility, like energy storage (industrial batteries) and electric vehicle batteries. (4)

Certainly, the EU has been at the forefront of global climate action and will continue to do so. We can see this in the ambition of the President-Elect of the European Commission, Ursula von der Leyen who plans to make Europe the first climate-neutral continent by 2050. (5)

Picking up on this theme of climate change, we know that it is something that is with us and to which we are vulnerable to, in the view of Maroš Šefčovič. In speaking points by Maroš Šefčovič on the EU preparation for the UN Action Summit published on 11th September 2019, he said there is no time to waste and draws our attention to the very hot summer that took place in 2019. One fascinating point he made concerns a vision for a climate-neutral Europe by the middle of this century. He details more about this bold ambition in his own words.

"We are delivering on our 2020 targets, we have legislated to overachieve on our 2030 contribution to the Paris

Maroš Šefčovič, Vice-President, Energy Union

Agreement, and we have put on the table a strategy to go climate-neutral twenty years after, already supported by a large majority of our Member States.

"We are also serious about financing our ambition, which is why we proposed that 25% of our next financial framework should be dedicated to climate-related activities, including for just and fair transition. And we remain the world's largest donor of international climate finance, with EU and Member States' contributions more than doubled since 2013." [6]

Another key figure at the European Commission in this policy area was Dominique Ristori, who worked there from 1978-2019. During his time there, he held several senior positions, his most recent one being Director-General for Energy. Another one of his positions he held was Director-General of the Joint Research Centre (JRC) between 2010 and 2013. Another was Director in Charge of General Affairs and Resources in DG Energy and Transport, from 2000 to 2006.

Ditte Juul Jørgensen has now replaced Dominique Ristori as Director-General for Energy and we wish her well in this role. Looking ahead to the period of the next Commission from 2019-2024 – we wish Frans Timmermans, who will be in charge of European Green Deal well, as well as the Kadri Simson, who will take care of energy - when they begin their new roles as they continue the crucial work to tackle energy and climate change. [7] ■

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Insight into novel kinds of solar cell technologies

Jan Macak, Senior Researcher and Group Leader at the University of Pardubice, Czech Republic, provides insight into novel kinds of solar cell technologies

The development of renewable sources of energy is widely recognised as a research priority today, with scientists looking to efficiently harness solar power to meet our energy needs. Solar cells are increasingly important devices for electricity production and have been considered as the most promising candidates to replace fossil fuels in traditional energy harvesting. In addition to traditional field installations and building integrated photovoltaics (PVs), they are envisaged to power, until recently, unpowerable devices (e.g. various sensors and electronic microdevices) and mobile objects (e.g. cars, drones). Besides the many efforts to develop various photovoltaic technologies for all these diversified applications, there is still room to improve the efficiency, performance, stability and cost figures of the solar cells. This naturally requires the development of new types of solar cells. Recently, perovskite-based solar cells have emerged and also, other thin-film technologies based on chalcogenides or organic materials show promise. However, these solar cells are thought to be used in the traditional setting of PV panels on building rooves and fields.

There is also a need for another type of solar cell that provides sufficient energy to directly power (i.e. without any use of battery) relatively small electrical devices and occupy at the same time only, a relatively small surface area (such as few cm^2). This is a different philosophy compared with the traditional large-scale PV installations that pump the produced energy to electrical grids or charge batteries in households. Such cell must be conceptually based on non-planar design, utilising highly nanoporous or nanotubular arrays with a huge internal surface to volume ratio, as shown in Figure 1.

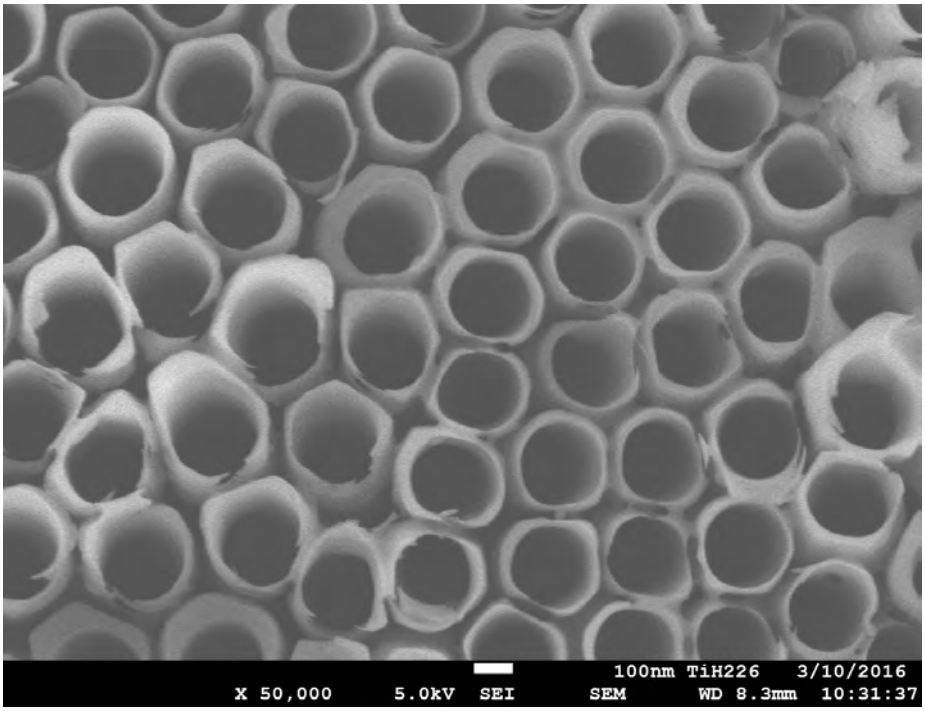


Figure 1: A scanning electron micrograph showing the top view of the TiO_2 nanotube layer. One can see hollow nanotubes that are closely packed to one another.

Dr Macak and his group are exploring such nanotubular arrays based on titanium dioxide (TiO_2) nanotubes in the Chromtisol project, a European Union (EU)-backed initiative based at the University of Pardubice in the Czech Republic. Layers of ordered nanotubular TiO_2, shown in Figure 1, offer much potential in this respect, says Dr Jan Macak. "It has become clear that they are unique, they possess large surface area in a small volume, are very stable upon irradiation and can be produced by simple technology. In combination with suitable chromophores, they can very efficiently absorb both sunlight and artificial light. They can efficiently convert this light into electrons, as outlined in Figure 2," he explains, "If you want to make a good solar cell, you have to make sure that it absorbs as much light as possible and reflects as little as possible," he goes on to explain. "Most silicon PVs installations are south-facing, to directly absorb

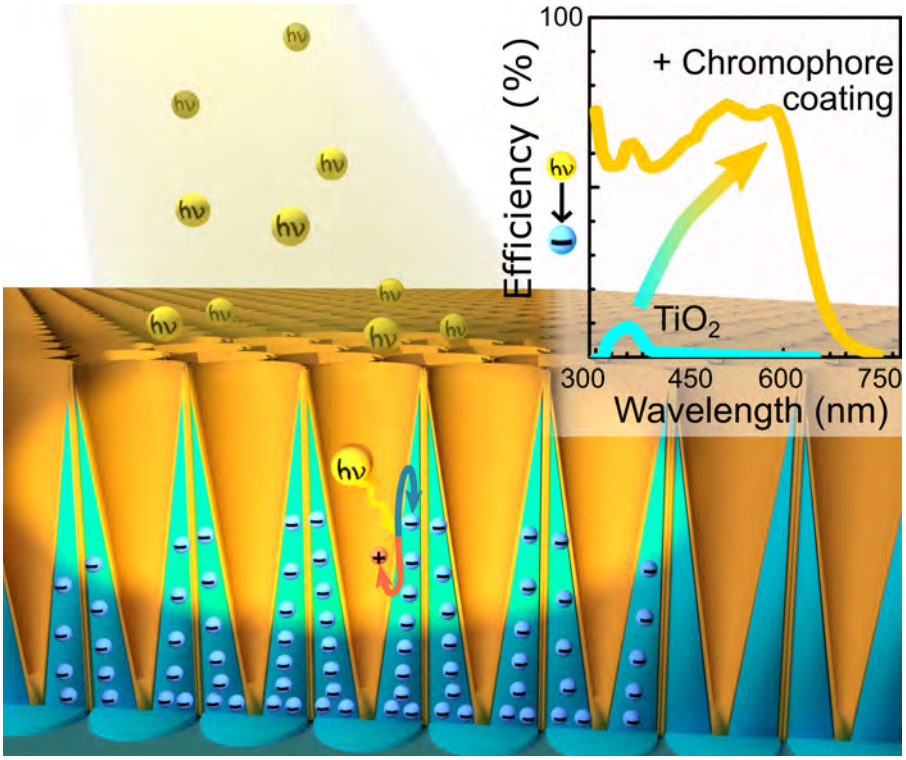


Figure 2: Sketch of the deemed solar cell that illustrates the absorption of light and consequent generation of electrons within TiO_2 nanotube layers containing a suitable type of chromophore. The inset graph shows an increase of the photon-to-electron conversion efficiency (IPCE) of the nanotube layer with the added chromophore.

sunlight. But there are also places which do not experience as much sun. The deemed solar cell can function very well at various angles of illumination," points out Dr Macak. Currently, the absorption rate is typically somewhere between 80-90%, which means that approximately 10% of light is reflected and not used. This is very little compared to other types of solar cells," he outlines.

This topic is central to the project's overall agenda. The nanotube layers act as a functional scaffold and provide a large surface area to the cell. "This is very important, because the larger the surface area, the better for the solar cell," explains Dr Macak. When light is shone onto a regular flat surface, a certain proportion is reflected; by increasing the surface area of the cell and adapting the morphology." Dr Macak aims to improve absorption efficiency. "The first major challenge in this project is to make sure that we absorb as much light as possible. TiO_2 intrinsically can absorb only UV light, but for a good solar cell, it is also important to absorb visible and infrared light. Putting these chromophores inside nanotubes is not easy however, as the scale is so small. "So the project is not just about developing the solar cell; it's also about finding the right strategy to put the correct type of chromophore inside the tubes. The aim is to utilise, as efficiently as possible, the space inside the tubes and to have the right nanotube geometry," continues Dr Macak."

A number of different strategies are available for this task. In one of the more complex approaches, researchers utilise a thin-film deposition technique called atomic layer deposition (ALD) to coat the interior of the nanotubes. "It's a fascinating technique that has a lot to offer to PV industry in general," says Dr Macak. This technique has already been exploited to make active components of various types of solar cells, but also ALD coatings can be used as antireflective, or even to coat the whole call to prevent them against ageing and moisture.

Overall, this new physical concept of a solar cell explores extremely promising materials, yet is unseen and unexplored in a joint device, whose combination may solve traditional solar cells drawbacks (carrier recombination, narrow light absorption).

"The costs would probably be a little bit higher than other cells, but the light management and the efficiencies have the potential to be really very high for the applications needed," he outlines. "Currently, we are producing a final prototype of the solar cell and we are excited about the results," he says. The team is also considering the possibility of scaling up the technology.

"Through our work in this project, we are also pushing the limits of ALD, which is a prominent topic in research. We are trying to use these deposition technique materials in quite an interesting way and this will be valuable for researchers and new applications in future," he says.

University of Pardubice

Jan Macak
Senior Researcher, Group Leader
University of Pardubice, Czech Republic
Tel: +420 466 037 401
jan.macak@upce.cz
www.upce.cz

Demand Response 101: How to get paid to cut power use for utilities

Rodrigo López, Energy Management Deputy Director, Fenie Energía, provides a detailed article about Demand Response, highlighting how you can save money on utility bills during periods of reduced energy use

Demand Response (DR) is one of the possible actions included in what is known as Demand Side Management (DSM). DR can be briefly defined as the ability of customers (from domestic to large industries) to vary their energy consumption during certain (usually short) periods of time. These (generally downward) changes in consumption can be both, on consumers initiative as per the utility's request in the event that clients are under some type of DR programme such as those shown below.

The so-called DR events are usually motivated, in addition to the incentive to save energy at times when it may be more expensive, due to any of the following situations: a) Punctual demand spike motivated, for example, by a heat wave in which air conditioning consumption soars. b) Temporary system generation capacity reduction due to, for example, the shutdown of a plant. Or because c) Problems with the transport system caused, for example, by a failure in power lines caused by a storm or forest fire.

Adoption of DR measures is experiencing a breakthrough in recent years mainly due to the following reasons: a) Electricity demand increase caused by a greater number of consumers with more and more electrical appliances, despite increasing awareness about energy efficiency. b) Electricity generation costs growth due the rising polluting fossil fuels price such as coal and gas. c) Rising strict regulations for generation plants that must undertake significant investments to reduce pollution. d) Increment presence of renewable generation, which, although it is true that it can reduce the generation price, introduces huge volatility both in volume and price in the system since in many cases they are not manageable technologies. And e) European directives such as the Winter Package that seeks to empower consumers and make them more involved in the energy system.

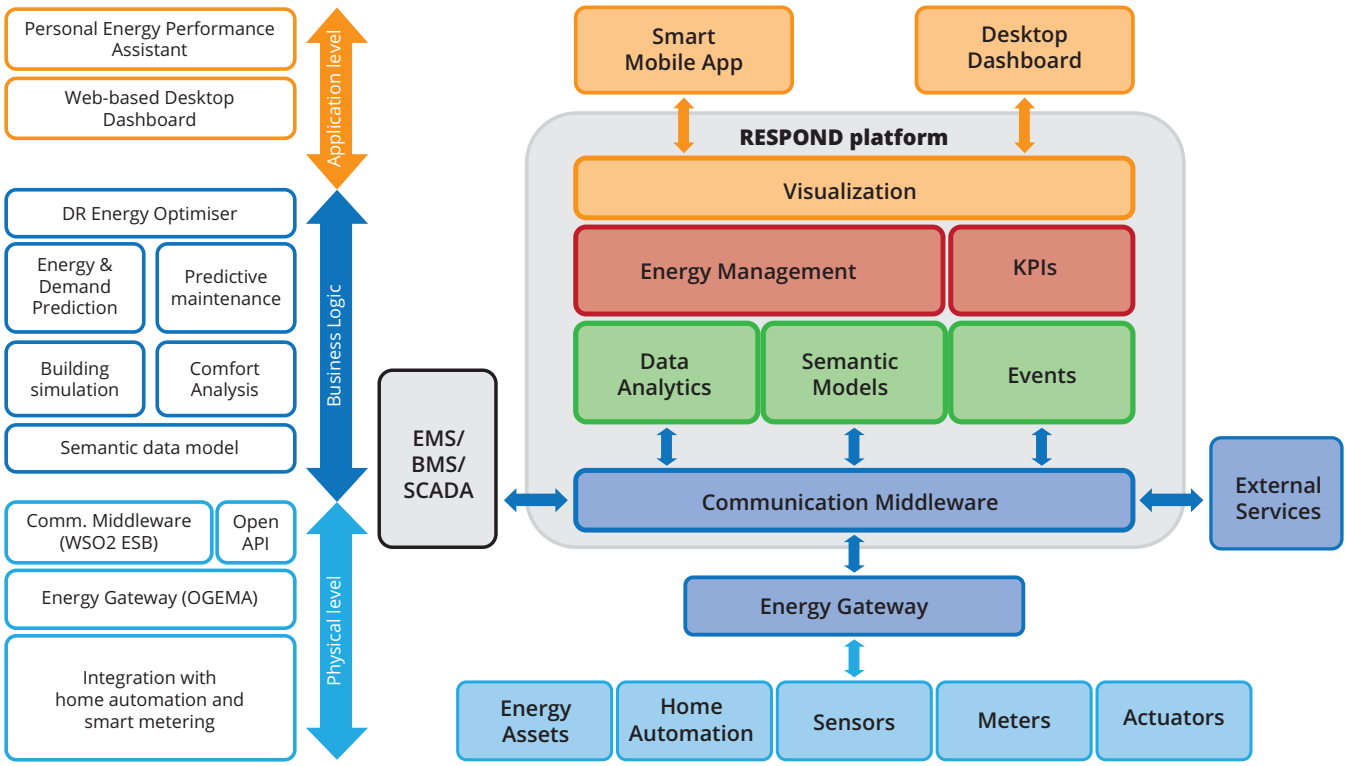
The rise of the DR is due to the fact that it provides benefits for all stakeholders: Clients, environment and utilities. The latter use DR measures to obtain advantages from a technical and commercial point of view. The energy demanded in an electrical system must be equal at all times to that generated. If the demand is high, it is necessary to turn on more generation plants which produce electricity at a higher price.

Therefore, the utilities can benefit on the one hand by activating mechanisms of load reduction by DR, thus reducing their need to acquire energy for their customers during price peaks and, on the other, in the case of owning generation plants of inflexible technologies, they can request to raise the load avoiding to stop such plants with expensive boot gradients.

Moreover, if a utility has made a mistake when forecasting its customers' demand and it is forced to acquire this extra energy in auxiliary markets at a higher price, it may request a load reduction by DR compensating customers at a lower price than the possible extra cost incurred in the market. From commercial point of view, it can also mean a new service to offer its customers to retain them and distinguish themselves from rival companies.

For clients, participate in DR programmes is essentially an economic benefit for the obtained reward from utilities for being available for (and in the cases required, to carry out) the required actions. On the other hand, contributing to security of supply is in its own benefit, for example preventing blackouts. At the same time, they may feel they are taking part in reducing pollution to achieve a greener future. To joint DR programmes customers only need to contact with their energy supplier and sign an agreement for this new service.

These actions can be classified as automatic or voluntary depending on whether the intervention of the user is necessary. For automatic execution it is necessary to install in customer premises both hardware and software to allow remote monitoring and operation. Some examples of DR actions are the temporary variation



of the thermostat temperature or to dim lights.

Additionally, there are also "passive" actions such as changing consumption habits, for example shifting certain tasks execution to periods of low price or reduced network overload. There is also the possibility of joining a price responsive programmes such as time-of-use (TOU) or critical peak pricing (CPP) rates.

DR has been widely used in large industrial customers given its high energy consumption, but its possible application needs to be demonstrated in small customers such as dwellings based on the idea that, although an individual small load modification is insignificant for the system, the sum of thousands of them, using the figure of the demand aggregator, could be very useful.

The H2020 768619 RESPOND project (Integrated Demand REsponse Solution towards energy POsitive NeighbourhooDs) (project-respond.eu) contributes to this study analysing the feasibility of DR in dwellings providing a software/hardware solution, able to work with legacy devices, that are being tested in three pilot sites (private apartment buildings in Madrid (Spain), social housing community in Aarhus (Denmark) and detached houses in Aran Islands (Ireland).

The project, that started in October 2017, is intended to last 3 years with an EU funding of over 3 M€ among the eleven partners of five countries (Czech Republic, Denmark, Ireland, Serbia and Spain). RESPOND's solution consists on a web-based user interface and a mobile app along with analytics services to measure both, trial participants engagement and energy savings.

RESPOND is part of the European Commission's Research and Innovation Program, known as Horizon 2020, from which it has received its funding by virtue of grant agreement no. 768619.

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RESPOND
DEMAND RESPONSE FOR ALL

Rodrigo López
Energy Management Deputy Director
Fenie Energía
rodrigo.lopez@fenieenergia.es

Andreu Pagès
R&D Project Manager
apages@dexma.com
DEXMA
Tel: +34 931 810 195
http://project-respond.eu/
www.twitter.com/project_respond
www.facebook.com/EUProjectRESPOND
www.youtube.com/watch?v=EeWLCJIZtTc

National Hydrogen and Fuel Cell Day: What you need to know

Morry Markowitz, President of the Fuel Cell and Hydrogen Energy Association details all we need to know about the National Hydrogen and Fuel Cell Day on October 8th and beyond that

This October 8th, fuel cell and hydrogen champions in both the private and public sector around the world will once again come together to commemorate National Hydrogen and Fuel Cell Day. This 'day', chosen as a nod to the atomic weight of hydrogen (1.008), has grown from a Washington, DC-focused event into an international celebration.

National Hydrogen and Fuel Cell Day was created five years ago by the Fuel Cell and Hydrogen Energy Association (FCHEA) as a rallying tool for the industry and supporters to share groundbreaking announcements, raise awareness of the technology and host events for both public and policymakers. This coordinated effort was devised in order have the biggest impact possible, breaking through the endless 24/7 news cycle to showcase the current benefits and future potential the technology brings to a range of applications and market sectors.

> "Countries are increasingly looking at hydrogen for large-scale energy storage and are deploying large systems to utilise excess hydrogen from renewables, such as wind and solar farms to help stabilise the grid and generate clean and reliable electricity at any hour, in any weather."

That first year was an impressive success, made even more so with the passage of a bipartisan U.S. Senate resolution. Every year since, National Hydrogen and Fuel Cell Day has grown beyond simply an industry event to include support from both houses of Congress, the participation of Federal agencies and National Laboratories, proclamations from state governments across the country and even engagement from companies and organisations abroad.

The rise in support for National Hydrogen and Fuel Cell Day is closely aligned with the growth of the industry

Morry Markowitz

itself, in the U.S. and internationally. Fuel cell passenger cars from major automakers have been available now for several years and there are dozens of fuel cell buses in operation in the U.S., Europe and Asia. The vehicle market is expanding to include medium and heavy-duty delivery vans and Class 8 trucks, with demonstrations and orders by some of the biggest logistics companies in the world. The material handling sector is continuing to grow, with more than 26,000 vehicles in operation or on order in America and new customers in Europe entering the fold. Fuel cells are also being integrated into everything from small, unmanned drones to the large passenger trains and ferries.

The global appeal of hydrogen as a fuel is its ability to be generated from a wide range of local sources and feedstocks, including natural gas, coal, organic waste/biogas, or by electrolysing water, using grid power or renewable solar or wind-generated electricity.

Outside of transportation, tens of thousands of hydrogen fuel cells are ensuring reliable and continuous power to communications networks, traffic and rail signals, surveillance and other equipment for a range

Secretary of Energy Rick Perry in a fuel cell car as part of last year's celebration

of customers, including wireless companies, utilities, first responders and government agencies. Large-scale fuel cell systems utilising natural gas or biogas are being installed by both the public and private sector, including some of the biggest utilities and corporations.

Countries are increasingly looking at hydrogen for large-scale energy storage and are deploying large systems to utilise excess hydrogen from renewables, such as wind and solar farms to help stabilise the grid and generate clean and reliable electricity at any hour, in any weather.

Once the festivities surrounding National Hydrogen and Fuel Cell Day subside, the momentum of the industry will continue at the 2019 Fuel Cell Seminar & Energy Exposition (FCS&EE) which will take place November 5th-7th at the Long Beach Convention Center in Long Beach, California. The FCS&EE is the longest-running and most comprehensive fuel cell and hydrogen conference in the U.S. and arguably the world. It combines high-level keynotes and plenary talks with a bustling exhibit hall showcasing the latest products through the entire supply chain; technical poster and breakout sessions on a range of R&D and commercialisation topics; and networking opportunities galore, with evening receptions every night.

Both these events, National Hydrogen and Fuel Cell Day and the FCS&EE, offer industry insiders perfect opportunities to voice support, highlight progress and create critical stakeholder relationships to keep the spotlight on this innovative and important technology and the fuel it uses. They also present a great opportunity for companies interested in learning more, be it as a potential supplier, partner, or customer, about the expanding potential and benefits fuel cells and hydrogen bring to the table. A technology that can provide power for any size, any need, any application, from almost any feedstock, definitely warrants and deserves the attention. ■

National Hydrogen & Fuel Cell Day | 10·08

Morry Markowitz
President
Fuel Cell and Hydrogen Energy Association
Tel: +1 202 261 1331
info@fchea.org
www.fchea.org
www.twitter.com/FCHEA_News

The need for a robust infrastructure & strong ambitions for hydrogen in Norway

Norway has set out a clear ambition to reduce the emissions from the transport, maritime and industry sectors. This requires multiple solutions where hydrogen plays a vital role. There is a strong focus to reduce emissions within the maritime sector and hydrogen is seen as a vital part of the solution

Norway has set out a clear ambition to reduce the emissions from the transport, maritime and industry sectors. This requires multiple solutions where hydrogen plays a vital role. Within the transport sector, the government has indicated that from 2025, no fossil cars can be sold. To achieve this, hydrogen cars in addition to battery electric vehicles, need to be a part of the solution. In addition, there is a strong push to decarbonise heavy-duty vehicles, such as buses and trucks. This will require robust infrastructure and a steady supply of green hydrogen at reasonable prices.

Strong hydrogen ambitions in many sectors

There is a strong focus to reduce emissions within the maritime sector and hydrogen is seen as a vital part of the solution. The first hydrogen ferry is under construction and will be in operation by 2021. In addition, other vessel types such as express boats and offshore vessels being prepared for hydrogen propulsion.

Within the land-based industry, a zero-emission roadmap has been developed towards 2050 and this shows the need for green hydrogen as a part of the solution. Projects like TiZir titanium production plant in Tyssedal will require large amounts of hydrogen to replace coal in its production. This plant alone will lead to a demand for up to 30 tons of hydrogen per day.

Hydrogen station accident, a bump in the road, but also a wake-up call for the government

The hydrogen deployment around the world has been done in a safe manner although some incidents have been reported. There was a significant setback for the Norwegian hydrogen industry when a hydrogen station in

Sandvika exploded in June this year. The root cause of the incident was a leakage from a valve that had not been installed according to procedures. All other stations were shut down as a result and the leading player in the deployment of hydrogen stations, UNO X seems reluctant to proceed with further hydrogen projects until the situation is further investigated.

Late in 2018, HYOP; the other company operating hydrogen stations in Norway, had to shut down their stations due to the lack of funding. Hence the hydrogen infrastructure development is far from robust and makes it highly risky for potential users to invest in hydrogen vehicles. As of August 2019, no hydrogen can be purchased in Norway and all the 150+ hydrogen cars are parked until the stations are reopened. The car manufactures Hyundai and Toyota have generously offered replacement cars to everyone affected by the situation. This has been necessary but is not a permanent solution.

Despite the dramatic situation for car owners and operators of the hydrogen stations, it seems like the momentum and political support for hydrogen is in place. If lessons are learned from this accident, better and even safer hydrogen stations will be the result. It must also be used as a wakeup call for the government as the development of a robust infrastructure to support the transport, maritime and industry sectors can hardly be done by private companies on a project-to-project base. An overall roadmap and system plan must be in place with substantial public funding to ensure that volume is achieved. Enova has been given this role, but even though the focus and funding targeting hydrogen have been increased the last years, Enova has failed to take on the role as the public funding partner of the national hydrogen infrastructure.

Public involvement and strong partnerships are vital

Different models for hydrogen infrastructure projects and roadmaps have been developed in other countries and a strong collaboration between the government, car manufacturers, hydrogen industry and energy companies has been seen as important in public/private partnerships all over the world. In Japan, California, Denmark and the UK, these types of models have been put in place and provided the necessary funding for an early phase development. On the discussion of whether you need cars or stations first, it is clear that without a robust infrastructure that allows users to fill hydrogen at a reasonable price, no vehicles will be sold. And with the shutdown of the hydrogen stations in mind, the robustness of the infrastructure will be a critical factor for future customers investing in hydrogen cars, ships or solutions for the industry.

At Greenstat, we remain strong in our focus on hydrogen as a zero-emission energy carrier needed to reach our climate goals. The industry and consumers are more than ready to invest in projects and hydrogen solutions. We hope that the government will provide a road map for the development of a robust hydrogen infrastructure and that it will follow up with the necessary funding.

GREENSTAT

Vegard Frihammer
Green Executive Officer/Founder
Greenstat AS
Tel +47 00 9282 6952 (Norway)
vegard@greenstat.no
www.greenstat.no/.com
https://twitter.com/frihammer

Hydrogen for transport in London

Dennis Hayter from Hydrogen London explores the extent of hydrogen-powered transport in the capital city of the UK, London

Air quality is a fundamental issue for London. London's air is so toxic and harmful it is causing a public health crisis. The recently recognised Climate Emergency also threatens the long-term security and wellbeing of every Londoner.

The current Mayor of London Sadiq Khan is committed to helping tackle these twin dangers by working with industry and the Government to ensure that a mix of innovative technology will transition London into a zero-emission and net zero-carbon city by 2050.

The London Hydrogen Partnership (now 'Hydrogen London') was established in 2002 as a public-private partnership between hydrogen industry and associated public and private entities, collectively forming a centre of expertise for hydrogen and fuel cell (HFC) technologies, and the Greater London Authority (GLA). The GLA is the devolved regional governance body of London, with jurisdiction over Greater London and the City of London.

Hydrogen London includes participants across the HFC spectrum, spanning hydrogen production, hydrogen distribution and fuelling station installation and operation; HFC technology developers; vehicle OEMs and vehicle/fleet operators; stationary and portable power systems suppliers and operators. The remit of the Partnership has broadly been to identify and implement HFC based initiatives that demonstrate and deliver impacts in addressing London's most pressing environmental challenges.

London first participated in HFC single deck bus trials during 2004-2006. These were deemed successful and leading to Transport for London (TfL) to adopt further HFC buses in 2011. In 2012, London operated a first full city centre, fuel cell-powered bus route (the RV1 Tower Bridge to Covent Garden route). These HFC buses ran for around 16 hours per day and the fleet covered over 1 million passenger service miles without fundamental issue. These fuel cell buses have been transferred and continue to operate on route 444 (Chingford – Turnpike Lane). With ongoing developments in the hydrogen sector, 20 double deck HFC buses are now set to enter the London bus network from 2020.

Other fuel cell electric vehicles (FCEV) have been deployed since 2011, including London taxis; passenger cars from Toyota and Hyundai in private fleet and taxi fleet operation – such as Green Tomato Cars running a fleet of 50 Toyota Mirai FCEVs; the GLA itself bringing FCEVs to their TfL and Metropolitan Police fleets – with the latter also fleet testing 2-wheel Suzuki Burgman scooters – and dual fuel hydrogen-diesel vans and service vehicles (such as for refuse collection). Hydrogen refuelling stations (HRS) have been opened in and around the London area to support FCEV deployment, with 10 publicly accessible HRS in operation (plus 2 non-public HRS sites).

Beyond transport applications, increasing use of HFC systems has been seen in construction-related sectors for replacement of site-based diesel generators and equipment power, such as lighting systems. Large scale (200kW+) stationary fuel cell systems have also been installed for combined heat, power and cooling provision in new office buildings.

Hydrogen London would like to celebrate these successes of hydrogen in London in recognition of National Hydrogen Day on 8th October. ■

Dennis Hayter
Deputy Chair
Hydrogen London
Tel: +44 (0)7958 066928
dennis.hayter@intelligent-energy.com
www.hydrogenlondon.org
www.twitter.com/hydrogenlondon

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Innovation in advanced lead batteries for a low carbon future

Dr Alistair Davidson, Director of the Consortium for Battery Innovation says that battery energy storage holds the key to a clean energy future. However, the growth in demand for batteries and the many different applications will require a range of battery technologies capable of delivering at scale

At the Consortium for Battery Innovation (CBI), we very much believe in delivering cutting-edge research to help take lead batteries to a new level of performance. It's important to promote innovation in the field for this proven battery technology for a range of applications, including energy storage and automotive.

CBI and its global membership have the common aim of inspiring the latest research to help develop the next generation of advanced lead batteries. When the world's leading battery manufacturers and research specialists come together, the standard is set for advanced lead batteries and the next generation of energy storage.

An interactive map was recently launched which demonstrates how new applications for lead batteries are supporting utility and renewable energy storage projects across the globe. It features examples such as microgrids supporting isolated communities and peak shaving which enables a short-term reduction in electricity consumption followed by an increase in production at a later time when power prices or grid demand is lower.

Lead batteries are essential today for powering start-stop vehicles which themselves have ushered in reductions in carbon emissions and are also used in hybrid and industrial vehicles – virtually all cars on the road contain a lead battery. Lead batteries provide over 70% of the world's rechargeable energy storage.

As a proven technology, lead batteries have a long track record of reliability and performance and tend to be lower cost. Resource management and sustainability are key for fast electrification and hybridisation of the economy and the very high recyclability (99% at end-of-life in Europe and North America) of lead batteries enables these huge growth predictions in energy storage.

As countries continue rapidly moving to a low carbon future, demand for battery energy storage is set to significantly increase. A range of technologies will be required to meet this demand and while lithium batteries will be a key player, the only other technology with the scale and capability to meet this vast unmet need in energy storage is the lead battery.

At CBI, we are always looking for new concepts and ideas in support of advancing battery capabilities and their applications. CBI recently announced a project in the United States to roll-out lead battery technology to support electric vehicle fast-charging stations.

Supporting green growth through recyclability and sustainability, lead batteries also provide key economic benefits to societies, with retired energy storage batteries possessing a scrap value as opposed to a disposal cost.

Looking ahead to the future, CBI has identified two priority research goals to really push advancements in lead battery technology for automotive and energy storage applications. A target increase of dynamic charge acceptance – the ability of a battery to accept instantaneous energy when charging – by five times by the year 2022 to 2 Amps/Ah has been set for automotive applications.

For energy storage, it is essential to increase battery cycle life – the number of complete charge and discharge during its lifetime – by five times by 2022 to 5,000 cycles. These will ensure that lead batteries remain at the forefront of the market for both applications.

Dr Alistair Davidson

To help achieve these goals, new technical research projects for 2019 onwards have been established, the details of which will be unveiled later this year but will include partnerships with universities, research institutes and battery manufacturing member companies.

> "Lead batteries are essential today for powering start-stop vehicles which themselves have ushered in reductions in carbon emissions and are also used in hybrid and industrial vehicles – virtually all cars on the road contain a lead battery. Lead batteries provide over 70% of the world's rechargeable energy storage."

In the last fifteen years, we have seen a dramatic improvement in lead battery performance. This is due to a range of things such as additives and new electrode architectures. However future applications, whether automotive or energy storage will place ever-increasing demands on the functionality of the battery. It's essential that lead batteries can adapt and improve through research and innovation to meet these requirements.

We expect to see steady growth in the automotive market for lead batteries in the next five years, whilst the energy storage system market is projected to expand dramatically. Energy storage across the globe is becoming ever more vital – not only for economies but also for societal needs such as renewable energy, electrification, circular economy and sustainability. Delivering research is, therefore, vital to drive lead battery innovation necessary to meet future energy storage needs. ■

Dr Alistair Davidson
CBI Director
Consortium for Battery Innovation (CBI)
Tel: +44 (0)207 833 8090
info@batteryinnovation.org
www.batteryinnovation.org
www.twitter.com/CBIbatteries

How heat flux sensors help in advancing thermal management of Lithium-ion cells

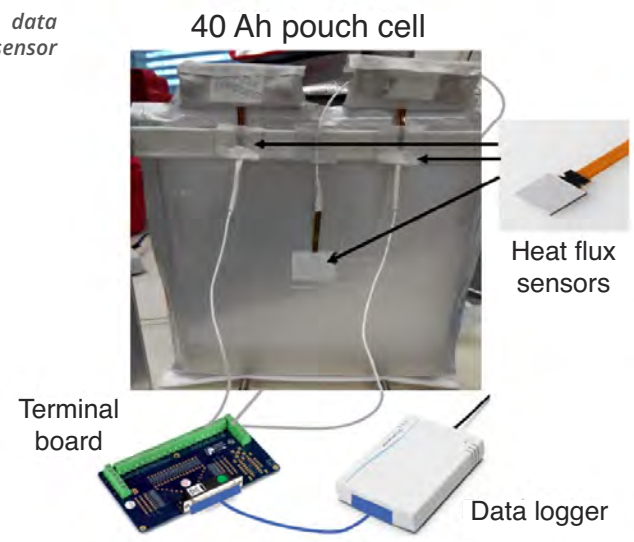
Dr Carlos Ziebert, Head of IAM-AWP's Calorimeter Center at the KIT, explains how heat flux sensors help in advancing thermal management

Established in 2011, the Calorimeter Center at the Karlsruhe Institute of Technology's (KIT) Institute for Applied Materials – Applied Materials Physics, operates Europe's largest battery calorimeter laboratory. It provides six Accelerating Rate Calorimeters (ARCs) of different sizes – from coin to large pouch or prismatic automotive format, which allow the evaluation of thermodynamic, thermal and safety data for Lithium-ion (or Li-ion battery) and post-Lithium batteries on material, cell and pack level for both normal and abuse conditions (thermal, electrical, mechanical). However, such a sophisticated calorimeter is not needed for all measurement types. Important thermal data can already be collected by a small heat flux sensor (HFS).

Measurements with a HFS

The thermal management of Li-ion batteries is becoming more and more important with increasing energy density because an uncontrollable increase in temperature (so-called thermal runaway) can cause an ignition or even explosion of the cell with a simultaneous release of toxic gases. In order to adapt the thermal management system to the individual needs of the cells, quantitative data of the thermal parameters are needed. It will be shown how heat flux sensors can be used to provide: i) Values for the specific heat capacity; ii) Heat transfer coefficients for the different sides of a cell and; iii) Values for the generated heat. A thermopile based Heat Flux Sensor is composed of tiny, serially connected semiconductor piles sandwiched between two flat surfaces, forming the sensor. Any heat flux passing through the sensor creates a temperature difference due to the Seebeck effect, which produces a voltage difference proportional to the heat passing through the surface. This voltage difference on different areas of a Lithium-ion cell is read out using a data logger, which is attached to a terminal board connecting the wires coming from the sensors (see Fig. 1). Depending on the sensor's sensitivity, the resulting values are converted into heat flux. A HFS can detect all three possible types of heat transfer: convection, conduction and radiation.

Fig. 1: Components for data recording using a heat flux sensor on Lithium-ion cells



Effective specific heat capacity

To measure the effective specific heat capacity Cp of a Lithium-ion cell, a HFS is attached on its surface and the heat flux response and a series of temperature steps are recorded, as shown in Fig. 2a). Integration of the peak areas and division by the cell mass gives the effective specific heat as a function of temperature (s. Fig. 2b)).

Heat transfer coefficient (HTC)

The heat transfer coefficient (HTC) h is another important parameter, that can be measured using a HFS. It is given as the quotient between the area of the sensor signal during the cycling of a cell and the area of a thermocouple signal at the same place:

$$h = \int \frac{U_{sensor}}{S(T)} dt \Big/ \int_0^t (T - T_C)\, dt$$

with S(T): sensor sensitivity.

In Fig. 3, it can be clearly seen that the HTC is determined by the classical dummy method (M1) differs a lot from

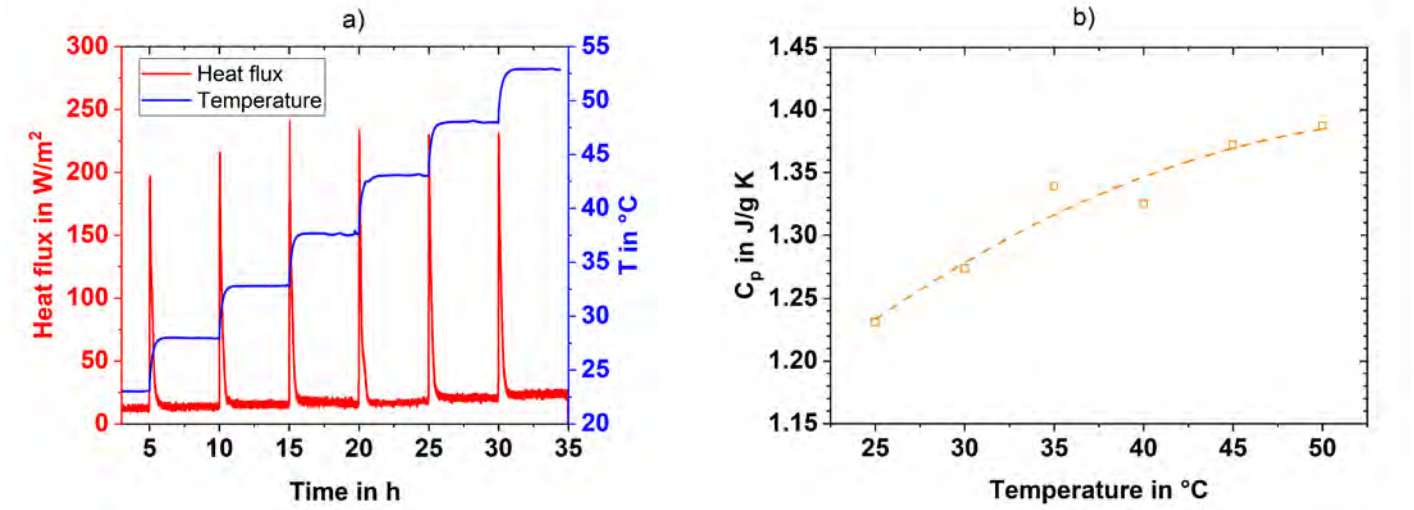


Fig. 2: Specific heat capacity of a 18650 cell: (a) Heat flux measurement (b) Derived values as a function of temperature

the one determined by a HFS (M3). In the dummy method, the heaters in the calorimeter chamber heat up a dummy, made from an Al alloy with similar mass and dimensions as the cell, stepwise. The HTC is determined from the slope of the curve of the temperature difference between the dummy and its surroundings vs. the time. Obviously, this situation differs from a Lithium-ion cell where the heat is generated from inside. However, there is a very good agreement between the HFS values (M3) and the values from M2, which are derived from an exponential fitting to the cooling curve after switching off the current. In addition, the HFS method allows measuring the HTC simultaneously as a function of temperature and applied charge/discharge current.

Generated heat

After the determination of the Cp value and the HTC, the temperature data that are recorded by thermocouples attached to the cell surface can be converted to the generated heat to determine cooling requirements for the thermal management system:

$$Q_{gen} = Ah \cdot \int_0^t (T - T_{env})\, dt + m\, c_p\, [T(t) - T(0)]$$

with A: cell surface.

Thus, heat flux sensors can determine many parameters that are of the utmost importance for the thermal management of cells. Moreover, they can be applied in the same way on the pack level by attaching them to different positions within the pack.

We hope that our research will help the European Battery Industry to make further progress in the field of thermal management.

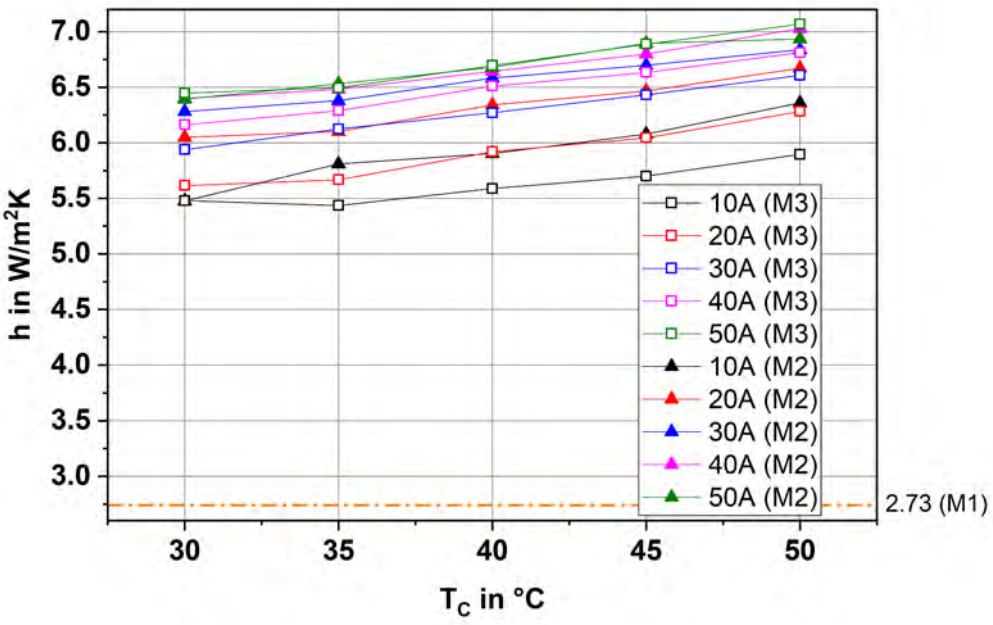


Fig. 3: Comparison of HTC of a 40 Ah pouch cell as a function of temperature and applied current for dummy (M1) , cooling curve (M2) and the HFS method (M3).

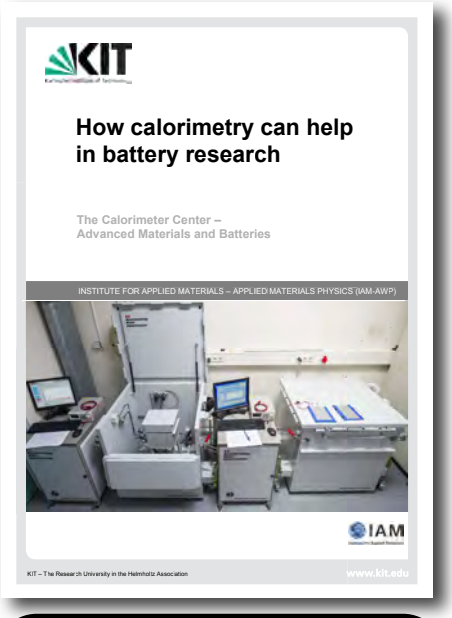
Karlsruhe Institute of Technology

IAM
Institute for Applied Materials

Dr. Carlos Ziebert
Head of the Calorimeter Center
Karlsruhe Institute of Technology (KIT)
Institute of Applied Materials – Applied Materials Physics
Tel: +49 721/608 22919
carlos.ziebert@kit.edu
www.iam.kit.edu/awp/english/index.php

How calorimetry can help in battery research

Established in 2011 the Calorimeter Center at the Karlsruhe Institute of Technology's (KIT) Institute for Applied Materials – Applied Materials Physics, operates Europe's largest battery calorimeter laboratory. It provides six Accelerating Rate Calorimeters (ARCs) of different sizes, from coin to large pouch or prismatic automotive format, which allow the evaluation of thermodynamic, thermal and safety data for Lithium-ion cells on material, cell and pack level under quasiadiabatic isoperibolic and environments for both normal and abuse conditions electrical, (thermal, mechanical).



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Karlsruhe Institute of Technology

Offshore wind: Five things we've learnt in the last year

In the run-up to U.S. Offshore Wind Conference, Eoghan Quinn, Global Wind Lead – New Energy for Worley, reflects on the ever-evolving environment of the offshore wind sector

Early last year, we saw construction begin on the world's first 1GW+ offshore wind farm in the North Sea – Hornsea 1 – with the first blades turning this February. As it edges closer to completion, the project is a signal to the world, the first firework of an impressive display. A major milestone in our transition to sustainable energy, the next generation of offshore wind projects will rival the capacity of traditional fossil-fuelled plants. Over the past 12 months, we've seen several key shifts in focus across markets, project specification, finance and expenditure.

OPEX costs are under the microscope

In the last year, developers have started to shift their focus away from CAPEX to OPEX. Economies of scale have driven down capex to a point where initial costs are becoming increasingly fixed, yet the OPEX bill for larger projects increases in line with its size. As more 1GW+ projects are set for development, the opportunity to streamline OPEX and improve ROI grows greater.

In tandem with this, we're actively using predictive maintenance techniques for asset performance management, which can lower lifecycle operational costs while maximising reliability without increasing risk.

Integration is dazzling

Bidding for work as part of a consortium is akin to being a contestant in a beauty contest. For the most part, we all share very similar attributes. So what can we do to stand out? Like any good pageant, some points are awarded for talent, and this year the trending skill is the know how to integrate offshore wind and green hydrogen into one project.

Twelve months ago, it was not something industry was talking about. Now, green hydrogen is a top topic for every single developer I meet. And while we don't expect to see hydrogen replacing gas anytime in the next five years, electricity from offshore wind would allow green hydrogen to be produced at scale in an economical way. As a result, clients are seeking to dip their toes in the water now, in preparation for what is to come. The Netherlands is likely to be a first-mover on green hydrogen, as its gas distribution infrastructure is suitable for conversion with minimal modification.

> "Well-established market players now see offshore wind as a commercially viable way to move into new energy. They bring significant clout in terms of investment."

No one size fits all in emerging markets

The emerging markets in Asia and the U.S. are gaining momentum, and with them, they are taking the experience gained in Europe to navigate through their individual challenges. However, the approach by each region could not be more different. While Asia is very energetic in its approach, the U.S. is more conscious of risk, with developers taking longer to embrace the opportunity fully.

Asia is leaning on its existing oil and gas supply chain, allowing it to move quickly. The U.S.'s offshore wind supply chain, having only delivered the Block Island project, is still very much at the embryonic stage and is somewhat hampered by the Jones Act, which requires goods being transported by boat between two American points, do so on American vessels.

Despite these challenges, there are many synergies which can be built on in America to smooth the path. By way of example, Orsted recently awarded Worley the design and engineering for two offshore wind topsides substations for its 'Revolution Wind' project in Rhode Island.

Saying goodbye to subsidies

Global costs of such projects have continued to come down to the point where, in certain markets and geographies, we are seeing projects planned with zero subsidies. In part, this is an effort by developers to compete against each other by offering projects that require no government finance. As projects become increasingly cost- competitive, the integration of different technologies, particularly green hydrogen, into one project is also becoming a key differentiator.

In a similar vein, we've seen an influx of household energy names into the space, looking to show shareholders they are committed to the energy transition. Well-established market players now see offshore wind as a commercially viable way to move into new energy. They bring significant clout in terms of investment.

Data is in the water

Operational data, collected over many years, is beginning to play a much greater strategic role. We've always had data to some extent but we are beginning to reap the benefits of using it to inform the way we develop and operate projects. It is becoming strategic in its role.

And the benefits are everywhere, from its ability to optimise the supply chain to reduce costs to informing how to extend asset life safely. Everything going forward will be digitally centric – much like turbines at sea, we'll be surrounded. So, what'll be important will be to stay conscious of what offers true value in a world of ever-increasing digital solutions and choices. ■

Eoghan Quinn
Global Wind Lead – New Energy
Worley
www.worleyparsons.com
www.twitter.com/Worley_ECR

Flexible and efficient electricity production

Prof Dr Anke Hagen, DTU Energy, highlights the importance of flexible and efficient electricity production as the energy sector continues to lower its greenhouse gas emissions

Climate and environmental concerns have gained a nearly unprecedented public attention worldwide. The reduction of emission of greenhouse gasses – such as CO_2 – in order to limit the global warming is among the biggest challenges of modern times. The energy sector, one of the major contributors, is transforming from large central power stations burning fossil fuels towards decentral, distributed units utilising renewable energy sources such as wind and solar.

The sustainable energy system of the future has to accommodate the electricity input from the fluctuating sources and has to provide/distribute electricity according to the consumer profile, also at periods of no wind / no sun, by utilising efficiently all sources of energy. This requires not only smart energy system control, but also efficient, flexible technologies for electricity (and heat) production using non-fossil fuels. Setting electricity (and heat) production into focus, the high temperature fuel cell (solid oxide fuel cell – SOFC) is a highly efficient and flexible technology.

In SOFCs, the energy of a fuel such as hydrogen or biogas is converted directly into electricity and heat, which allows for higher electrical efficiencies as compared to combustion based conventional power stations. Values of 50% and higher can be achieved at the system level. The sketch below illustrates examples for the manifold opportunities to apply SOFC technology.

One attractive, non-fossil energy source is biomass and here in particular waste biomass. This includes residues from wastewater treatment, human waste, agricultural waste, etc. Biomass is a large energy source, worldwide. If not stored and used properly, it contributes to the emission of greenhouse gasses (CO_2 and methane), for example from open waste disposal sites.

Selected fuels and applications for high temperature fuel cells

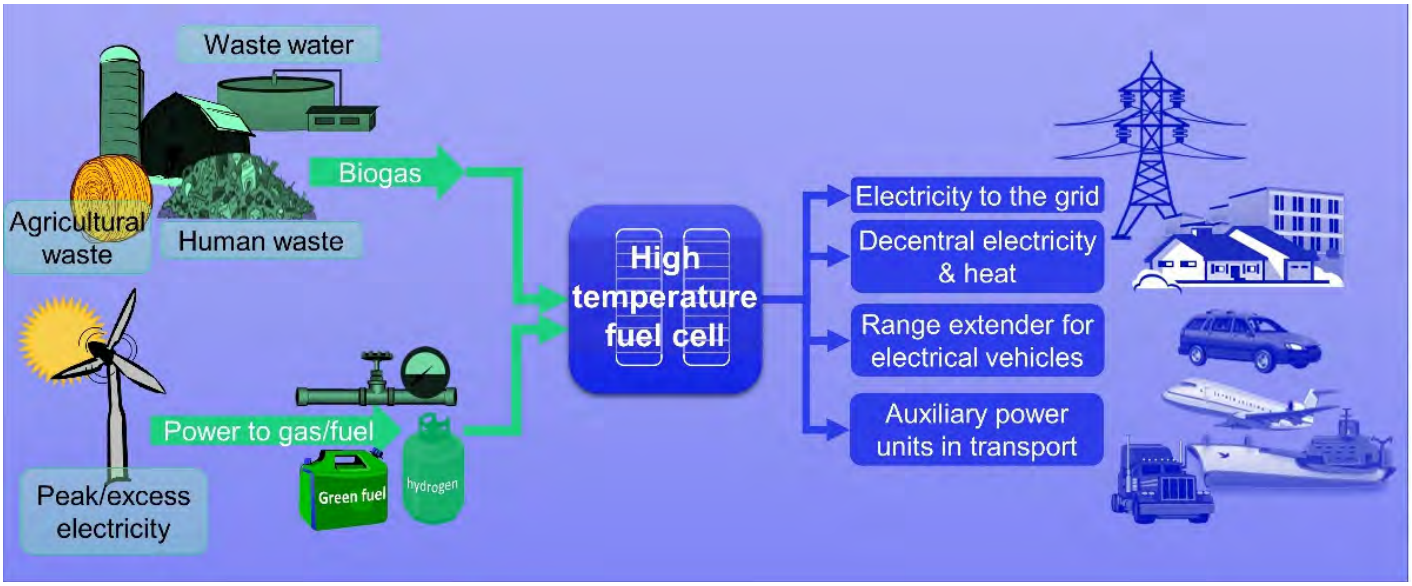
Biogas from various types of waste is a direct fuel for SOFC, i.e. after a general cleaning step, it does not need further gas treatment or separation. An interesting case is biogas from human waste, which forms naturally in the well-isolated landfill sites. The biogas contains large shares (ca. 50%) of CO_2 and is often diluted and thus difficult or impossible to use in combustion engines.

In addition, the specific biogas composition changes over time and depends on the waste type, overall, a challenging fuel to handle. A recent experimental study showed that such biogas is suitable for SOFC, reaching close to 50% electrical efficiency without any optimisation (see full article from A. Hagen, H. Langnickel, X. Sun, title: Operation of Solid Oxide Fuel Cells with Alternative Hydrogen Carriers, published in: Int. J. Hydrogen Energy, 44 (2919) 18382-18392). SOFC is thus a powerful technology to literally convert garbage to a valuable product and reduce greenhouse gas emissions at the same time.

"In SOFCs, the energy of a fuel such as hydrogen or biogas is converted directly into electricity and heat, which allows for higher electrical efficiencies as compared to combustion based conventional power stations."

More mature examples of SOFC applications use natural gas – other fuels like hydrogen are possible – in stationary units at different scales. For example, the EU PACE project, sponsored by the Fuel Cells and Hydrogen 2 Joint Undertaking, will install more than 2,800 Fuel Cell micro-Cogeneration units in 10 European countries by 2021 – most of them containing SOFCs. They deliver electricity and heat to houses and small businesses.

In order to reduce CO_2 emissions from the transport sector, mainly two solutions are in focus: electrical vehicles and hydrogen fuel cell cars. Their introduction and operation cause significant cost challenges. From a user perspective, the problems of an electrical vehicle are the short ranges and the long fuelling times, while the lack of a sufficient net of hydrogen filling stations is a problem for hydrogen fuel cell cars.



Furthermore, at present most hydrogen is not yet produced via renewable paths but from natural gas – a fossil fuel. SOFC combined with a battery provide an alternative solution. Here the benefit of driving electric unites with a long driving range (several hundreds of km), short fuelling time (few minutes), and dense coverage of fuelling stations from the SOFC side, because they can operate with liquid fuels available from the existing infrastructure. From a society point of view, CO_2 emissions are reduced and significant investments saved.

A recent system study including commercial vehicles demonstrated impressively how the battery-SOFC vehicle solution extends the driving range, even for a battery size reduction by 50%, which saves expensive battery materials, production costs, vehicle weight, etc. Ranges close to the ones common for conventional diesel/petrol cars are within reach. The integrated SOFC technology uses liquefied petroleum as fuel and acts a range extender. Other fuels are possible as well, including hydrogen (see full article by Y. Bessekon, P. Zielke, A. C. Wulff, A. Hagen, title: Simulation of a SOFC/Battery powered vehicle, published in: Int. J. Hydrogen Energy 44(3) (2919) 1905-1918).

"In order to reduce CO_2 emissions from the transport sector, mainly two solutions are in focus: electrical vehicles and hydrogen fuel cell cars. Their introduction and operation cause significant cost challenges."

This hybrid solution already exists in reality. Nissan unveiled a battery-SOFC vehicle during the Olympic Summer Games in Rio de Janeiro in 2016. Owing to the widespread availability of bioethanol in Brazil, the SOFC was developed for the use of this specific fuel, in that way achieving a closed carbon cycle and reducing CO_2 emissions. Apart from extending the range of vehicles, SOFCs are also attractive to deliver electricity to trucks or ships using on board fuel and avoiding emissions of particles or toxic nitrous oxides as it is the case when an idling motor provides the electricity.

SOFC technology holds key advantages for shaping a flexible, sustainable energy system, both, in stationary and transport applications. The fuel flexibility and possible high electrical efficiencies allow for reduction of greenhouse gas emissions during electricity production, for delivery of electricity to numerous applications according to the desired consumer profile, and for saving of significant investments by utilising of existing fuel opportunities at present and in the future (biogas, hydrogen, etc.).

Prof Dr Anke Hagen
Professor
DTU Energy
Tel: +45 4677 5884
anke@dtu.dk
www.energy.dtu.dk/english

Asia focus: Innovations in renewable energy

Exciting innovations in renewable energy in Asia are placed into the spotlight here by Jack Terry, Copywriter at VHR Global Recruitment

The renewable energy market is constantly innovating, finding new ways to become cheaper, more efficient and more attractive to both companies and governments.

In Asia, great strides have been made in renewable energy, with some of the highest amounts of investment around the world. China has a stranglehold on the renewables industry, holding almost a third of all renewable energy patents. It's also the world's largest producer and exporter of solar panels, wind turbines, batteries and electric vehicles. This has helped expand the renewable capabilities of the region, challenging the established dominance of fossil fuels.

The bottom-up structure of renewable energy is a paradigm shift for utilities, traditional fossil fuel companies have always generated energy and sold it on to consumers. Now, consumers have the ability to generate their own power and sell the excess on. This energy transformation has big implications for global power.

Innovations in technology

Google is investing heavily in renewable energy in Taiwan, earlier this year they purchased a 10-megawatt solar facility in Tainan City. A collaboration between the search engine giant and the Taiwanese government, this follows similar deals in renewables Google has made in the U.S. and Europe. The new facility will be

connected to the regional grid, while also powering Google's nearby Changhua Country Data Centre.

It also marks another step forward for Taiwan going carbon neutral. The government has recently made changes to the island's Energy Act, allowing non-utility companies to purchase renewable energy installations. This is likely an attempt to increase investment and generate new business while also making cost-effective transitions into clean energy, a win-win for all involved.

> "It's great to see innovations like this driving the marine industry forward, helping to protect the environment in threatened regions. It's proof that the technology is not only a viable alternative to fossil fuels, it's the better option."

In Thailand, there is a project underway to build a 220-megawatt solar plant in Myanmar. This is the first large-scale renewable project in the country and the largest in the Association of Southeast Asian Nations made up of Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, the Philippines, Singapore, Thailand and Vietnam. It will be first of many, as these are some of the areas most vulnerable to the devastating impacts of climate change. To counter this, the ASEAN group has the goal of generating 23% of energy from renewables by 2025.

Energy consumption in Southeast Asia has almost doubled since 2000 and will likely double again by 2040. To stay in line with demand, the region will have to increase renewable energy generation.

Vietnam is one of the country's leading the charge, with improved tariffs for wind and solar initiatives that reward energy providers for each unit of electricity that's fed into the supply grid. So it's not surprising the country has plans to introduce at least 400 megawatts of solar and 500 megawatts of wind energy over the next few years.

Cheaper and more flexible equipment has helped developing nations make great strides with renewable energy that wouldn't have been possible a decade ago, but this isn't only happening in energy generation on a national level, it's also changing the transportation sector.

Innovations in shipping

Historically, the shipping industry has been one of the worst polluters in transport. This is due to the dirty fuel used by ships – large cargo trawlers use a type of fuel with 3,500 times more sulphur in it than the diesel fuel used in cars. The International Council on Clean Transport has found that China, Japan and India are the three countries with the highest amount of premature deaths linked to shipping pollution.

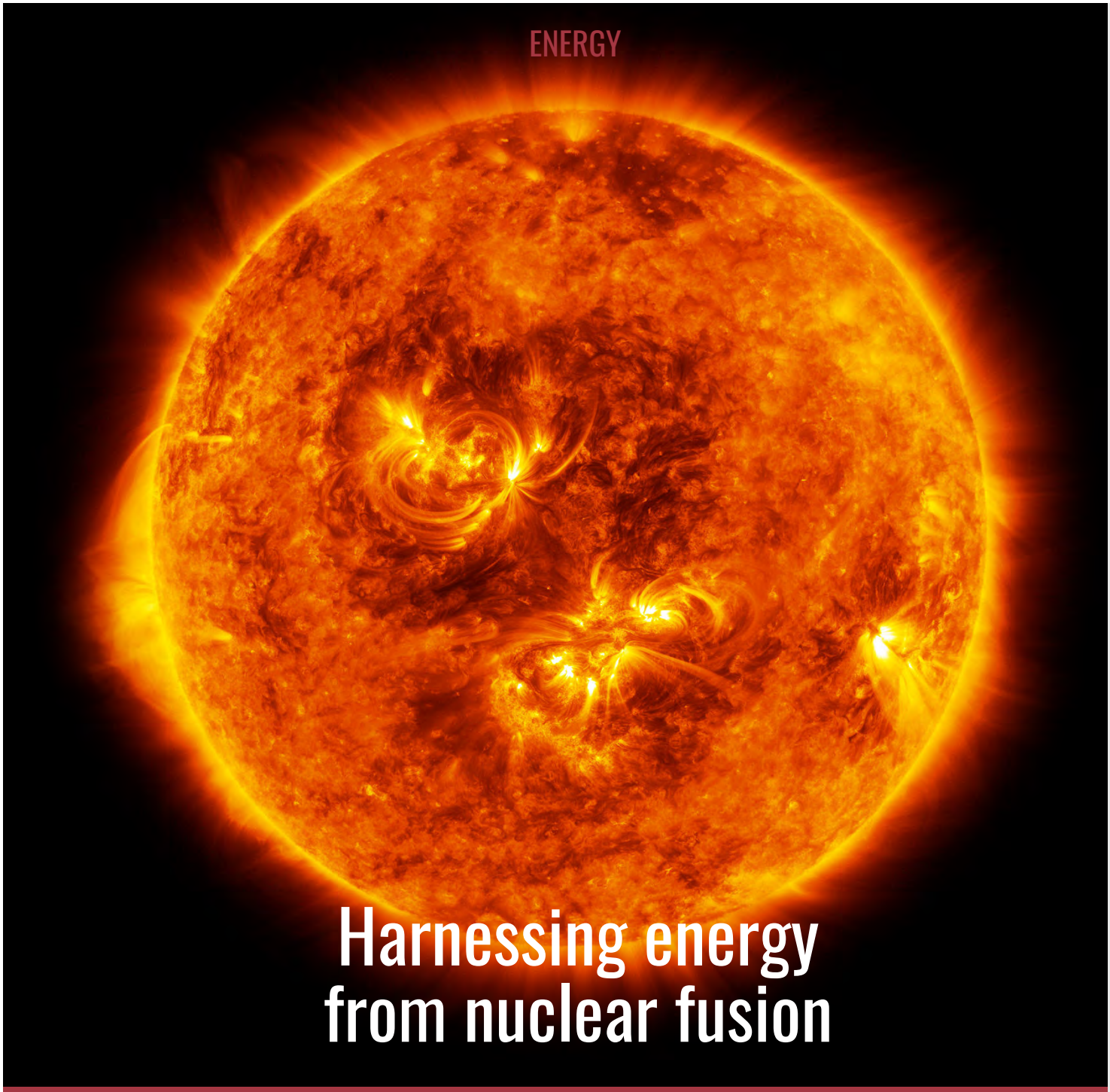
Much of the industry is committed to halving carbon emissions by 2050, but more ambitious projects have their sights set on creating zero-emission ships.

Japanese shipping company NYK Group has unveiled plans for a completely emission-free ship, powered through solar panels and hydrogen. It features a cutting-edge hull that reduces power demand by 70% thanks to its reduced weight and hydrodynamic design.

"It's great to see innovations like this driving the marine industry forward, helping to protect the environment in threatened regions. It's proof that the technology is not only a viable alternative to fossil fuels, it's the better option," says Alejandro Bello Perez, Marine Expert at VHR Global.

Currently, just a concept, ships like this could pave the way for truly green shipping that allows for seamless international trade without comprising the environment. ■

Jack Terry
Copywriter
VHR Global Recruitment
Tel: +44 (0)207 500 7980
www.v-hr.com/marine/
www.twitter.com/VHRofficial



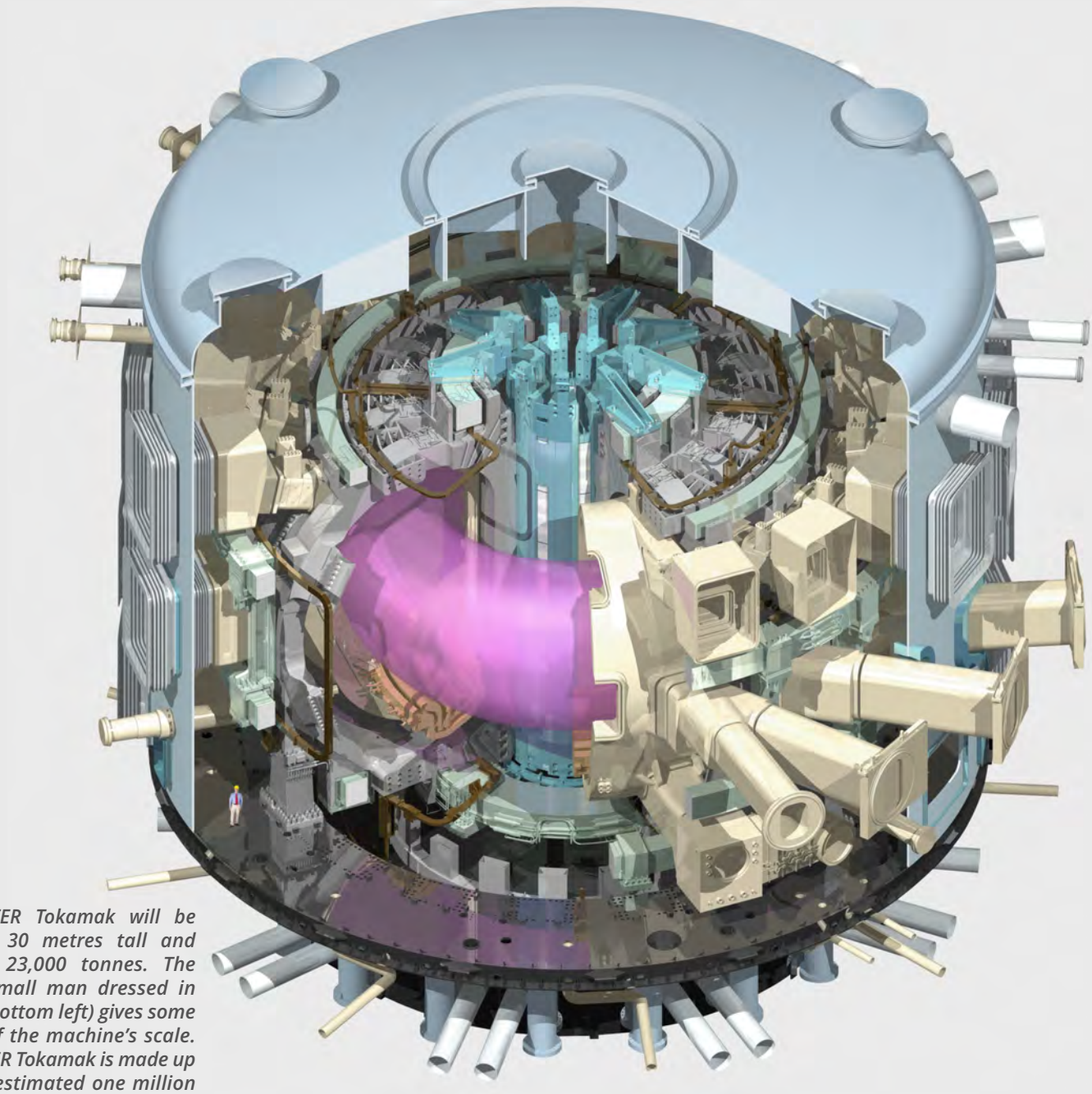
Harnessing energy from nuclear fusion

Matteo Barbarino, Sehila Gonzalez de Vicente and Danas Ridikas from the International Atomic Energy Agency (IAEA) give some useful information about harnessing energy nuclear fusion

Providing energy from nuclear fusion is widely regarded as the grand engineering challenge in the energy field. Many researchers and engineers across the world are focusing on ways to produce this energy by recreating on earth the conditions, such as density and temperature, that naturally occur in stars.

Unlike nuclear fission, where atoms are split to produce energy, in fusion, lighter nuclei are joined together to create heavier nuclei, resulting in the release of energy. This is how stars convert tiny amounts of mass into vast amounts of energy. Life on earth would not be possible without the nuclear fusion reactions that power the sun.

Despite the expected benefits of generating energy from fusion for society, such as the abundance and accessibility of fuel, the carbon-free footprint and the absence of high level radioactive waste, putting fusion into practice remains one of the most challenging areas of experimental physics and engineering today; controlling a fusion reaction at over 100 million degrees Celsius is a complex and challenging undertaking.



The ITER Tokamak will be nearly 30 metres tall and weigh 23,000 tonnes. The very small man dressed in blue (bottom left) gives some idea of the machine's scale. The ITER Tokamak is made up of an estimated one million parts. (Image: US ITER)

Once this challenge is overcome, fusion energy can become a virtually inexhaustible, safe, environmentally friendly and universally available energy source capable of meeting global energy needs.

How does fusion work?

At the core of a star, fusion reactions between hydrogen atoms take place within a dense plasma, with temperatures exceeding 10 million degrees Celsius. Plasma is the fourth state of matter and has unique properties, distinct from solids, liquids and gases. It consists of freely moving, charged particles and is formed at high temperatures when electrons are removed from neutral atoms. As we currently understand, more than 99% of the universe exists as plasma, including interstellar matter and stars, such as our sun.

In a controlled nuclear fusion power plant, three conditions must be fulfilled:

- Very high temperature (over 100 million degrees Celsius) to provoke collisions of highly energetic particles;
- Sufficient particle density in the plasma – where the reaction takes place – to increase the probability of these collisions and;

Aerial view of the ITER construction site, June 2019. *(Photograph: ITER Organization)*

- Sufficient confinement to hold the plasma and enable the fusion reactions to take place on an ongoing basis.

To date, the confinement concept with the best results has been the tokamak, a doughnut-shaped configuration first invented in the 1950s, which uses powerful magnets to contain the plasma. Tokamak machines can already provide the essential conditions for fusion, in terms of both plasma density and the required temperature and fusion reactions can, therefore, be generated. What is still missing to ensure the production of net power is better and longer confinement, which is a measure of how good the magnetic field is at maintaining the plasma energy over time.

What is ITER and why is it so important?

ITER (International Fusion Energy Organization), a collaboration between 35 countries, will be the largest fusion experiment on earth. It is under construction in Saint-Paul-lez-Durance, France and is scheduled to become operational at the end of 2025.

ITER is designed to demonstrate much higher gains in fusion power than other fusion experiments conducted to date. Following the injection of 50 MW of heating power, it aims to produce 500 MW of thermal power for long pulses of 400 to 600 seconds. Even though ITER will not capture the power it produces as electricity, it will pave the way for a machine that can.

The next stage after ITER, converting heat into electricity, will be addressed by a demonstration fusion power plant known as DEMO. DEMO is expected to explore and demonstrate continuous or near-continuous operation, fuel self-sufficiency and the large-scale production of energy, including its conversion to electricity and could be connected to the power grid by approximately 2050.

Does fusion produce radioactive waste in the same way as nuclear fission?

The easiest fusion process to achieve involves two isotopes of hydrogen: deuterium and tritium. Tritium is

"A mixture of Deuterium and Tritium – two Hydrogen isotopes – will be used to fuel future fusion power plants. Inside the reactor, Deuterium and Tritium nuclei collide and fuse, releasing Helium and Neutrons." *(M. Barbarino, Nuclear Plasma Fusion Specialist, IAEA)*

radioactive, but its half-life is short (12.32 years). It is only used in relatively low amounts, so, unlike long-lived radioactive nuclei, it does not present any serious danger.

This deuterium-tritium reaction yields a helium atom (an inert gas) and a neutron, whose energies can be harvested for powering the reactor and producing electricity, respectively. Therefore, fusion reactions do not create long-lived radioactive waste.

However, fusion will result in the generation of neutron-activated materials surrounding the plasma. In other words, when neutrons (as a result of fusion reaction) collide with the reactor walls, its structures and components become radioactive. Therefore, one of the important challenges when building future fusion power plants is to optimise the construction design in order to minimize this neutron-induced radioactivity and resulting radioactive waste volumes.

What is the IAEA's role in fusion plasma and fusion technology?

Since its inception in 1957, the IAEA has continuously supported nuclear fusion research. The IAEA undertakes numerous nuclear fusion activities, under the guidance of the International Fusion Research Council, an IAEA advisory body with members from around the world.

The IAEA coordinates international efforts in fusion research and technology development by involving nuclear physicists, materials scientists, nuclear data specialists, engineers and plasma experts, among others. It also organises the Fusion Energy Conference – the world's largest international event in the field of nuclear fusion.

Through the DEMO Programme Workshop, the IAEA also acts as a central hub in developing programme plans and initiating new research and development activities, in order to formulate various concepts of demonstration fusion power reactors.

Through coordinated research activities, several networks of small fusion devices have been established and are being successfully used to enable an integrated approach in the quest for solutions to a number of outstanding issues.

Furthermore, the IAEA aims to broaden the education and training of the next generation of fusion scientists and engineers. This is particularly important, as fusion research and development activities increasingly require cutting-edge technologies, expanding beyond the horizon of present-day know-how. ■

International Atomic Energy Agency (IAEA)
Fusion-Physics@iaea.org
https://nucleus.iaea.org/sites/fusionportal/
www.twitter.com/iaeaorg

Results in plasma jet driven magneto-inertial fusion (PJMIF) and the race for fusion energy

Dr Samuel Langendorf, Los Alamos National Laboratory, details some interesting results in the area of plasma jet driven magneto-inertial fusion (PJMIF) and his thoughts on the race for fusion energy

In the five previous Open Access Government articles, we have described the plight of controlled nuclear fusion research over the past decades and have chronicled the progress of our work on an innovative new approach called plasma-jet-driven magneto-inertial fusion (PJMIF.)[1] In this article, we present current conclusions and directions of our research in PJMIF and remark on the changing landscape of fusion energy research, driven increasingly by private investment, public-private collaboration and growing global alarm at the rapid onset of anthropogenic climate change.

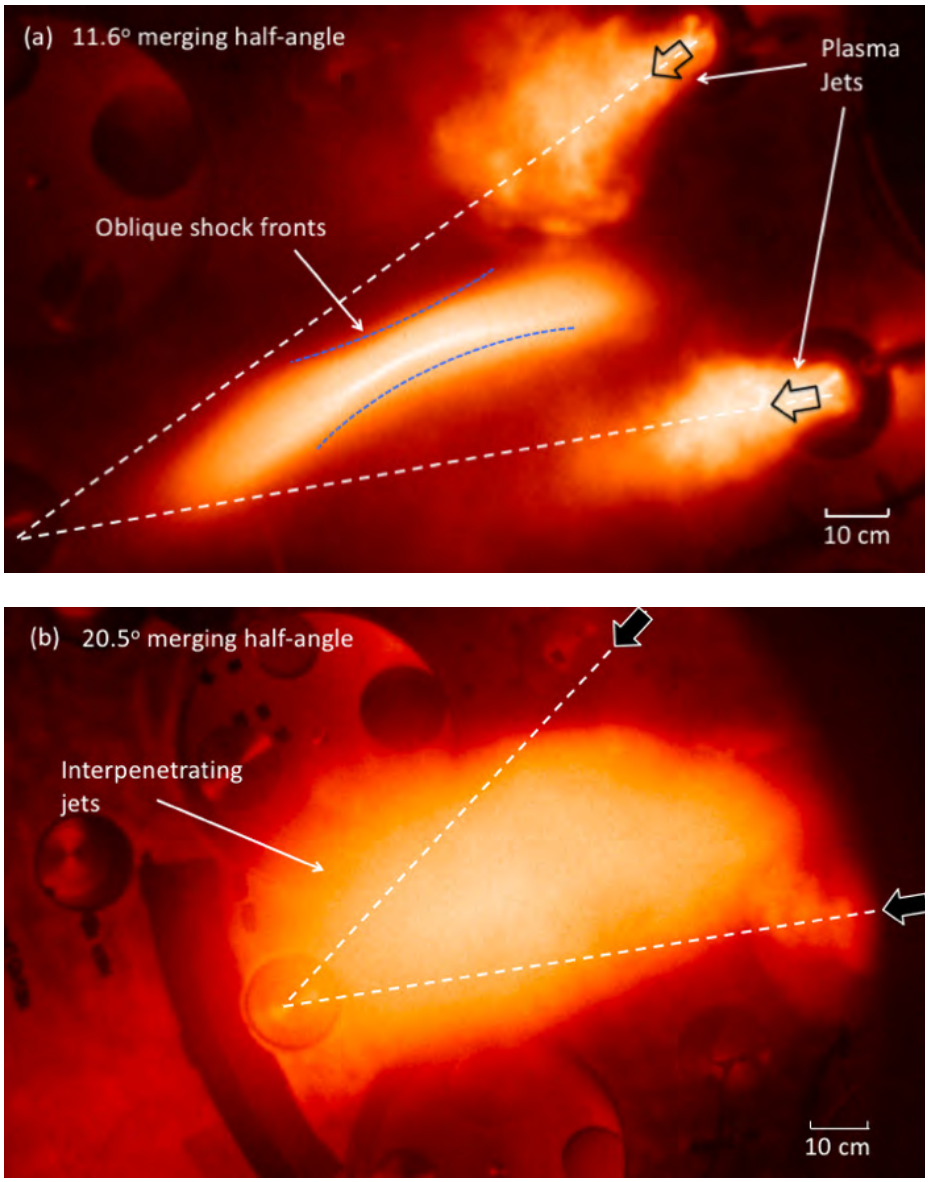


Figure 1 - Fast camera visible-light images of supersonic plasma jet merging at PLX

We are exploring the physics of PJMIF at the Plasma Liner Experiment (PLX) at Los Alamos National Laboratory. One of the most important questions that PLX is designed to explore is: can a smooth, supersonic, spherically imploding plasma liner actually be formed from the merging of discrete plasma jets? Standard computer simulation techniques for dense plasmas, based on hydrodynamics, suggest that the formation of shock waves between merging jets may lead to significant density perturbations in the formed liner, making it difficult or perhaps even impossible, to form the desired smooth spherical liner. However, simulations disagree[2,3] on the sharpness and magnitude of the perturbations predicted to be formed by the shocks, with little experimental data available in the intermediate-density regime that PJMIF targets. At PLX, we performed experiments to obtain benchmarking results for these models in a relevant parameter regime.

To explore the physical processes underway in the jet merging, we used the coaxial plasma guns designed and built by HyperJet Fusion Corporation (detailed in several of the preceding articles in this series) to fire supersonic plasma jets and collide them at an oblique angle. These experiments are conducted at reduced energy levels to those estimated to be required to produce breakeven fusion, but allow the physics to be studied at a greatly reduced cost. By varying the angle of the jet merging, we can study the effect of the jet relative velocity on the merging processes. Example fast-camera images of the plasma jet merging are shown in Figure 1.

The observations indicate there is more to the story of the merging plasma jets than the hydrodynamic prediction alone would indicate. For example, in Figure 1a, jets collide at a relatively shallow angle and low (but still supersonic) relative velocity and shocks form in accordance with hydrodynamics. At steeper merging angle, however, shown in Figure 1b, rather than a stronger shock wave as predicted by hydrodynamics for the higher relative velocity, a smoothed and diffuse merging structure is observed. We find this result to be due to significant interpenetration of the jets occurring on the merging length scale, preventing the formation of a sharp density perturbation as would occur in a hydrodynamic shock.

With benchmark data such as these now available from PLX, we can look forward to projected results at fusion-relevant scale. Such plasma liners would be denser by orders of magnitude than the PLX experiments, raising the question of whether the smoothing effects of interpenetration observed at PLX can be sustained at a fusion-relevant energy scale. Looking at plasma interpenetration theory, we project that similar smoothing will indeed be achievable if the liner is driven at a higher velocity, an encouraging result for the hope of utilising PJMIF as an effective fusion compression driver. These and other results from PLX are detailed in the current[4,5] and upcoming publications.

Going forward, we are upgrading PLX to perform hemispherical and ultimately fully spherical experiments, with a significantly increased number of plasma guns. At the time of this writing, 18 new plasma guns have been delivered by HyperJet Fusion Corp. and hemispherical and spherical experiments are planned with up to 36 guns before the end of the calendar year. Such experiments will give important results on the density amplification and ram-pressure scaling achieved in spherically convergent geometry, information that is a key metric of the concept performance and needed to benchmark designs of a full-scale driver.

To conclude this article series, we recall the case made by Dr Scott Hsu in the first article in this series, which is that fusion energy development has been held in check in recent decades by two factors: a high ~$10 billion capital cost of modern facilities and a lack of urgency and public political will in fusion energy development. Today, three years later, the first factor may be finally showing signs of weakness due to aggressive new scientific approaches aimed to achieve economical fusion power at a much cheaper development cost than the current worldwide tokamak-based path. These approaches include PJMIF and other exciting projects[6,7] supported by the ARPA-E ALPHA program, as well as new approaches in magnetic confinement fusion that seek to use high-temperature superconducting magnets to achieve a productive tokamak reactor at significantly reduced size and facility capital cost[8]. The second factor, lack of urgency will, may also be weakening as the effects of climate change grow ever more severe and apparent. Private risk capital and philanthropic interests have moved to support fusion at unprecedented levels and the government has responded with new programmes such as the DOE Office of Fusion Energy Sciences INFUSE program to complement that effort. Whether these approaches will be enough to achieve practical fusion power in time to impact climate change, only time will tell.

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HYPERJET FUSION CORPORATION

Samuel Langendorf
Scientist
Los Alamos National Laboratory
Tel: +1 505 667 9292
samuel.langendorf@lanl.gov

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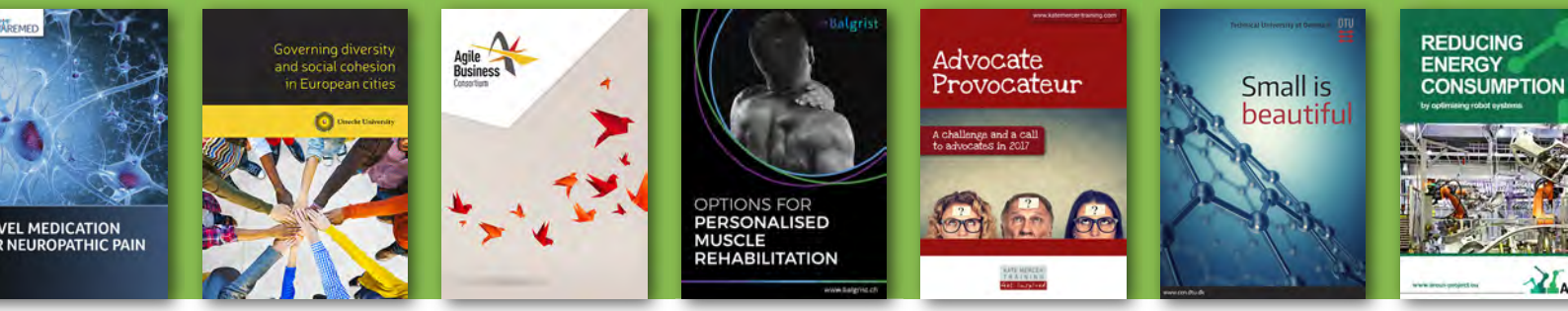

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Transforming Construction: Driving innovation

Sam Stacey, Challenge Director, UKRI Transforming Construction, talks to PBC Today about why he took on the role, the key aims of the Transforming Construction Challenge and the future of precision manufacturing and offsite construction

Sam Stacey is leading the Transforming Construction Challenge, which is backed by £170 million in research and innovation investment, matched by £250 million from industry, to create new construction processes and techniques for building manufacture in the UK.

Prior to joining Innovate UK, he was director of innovation, industrialisation and business improvement at Skanska UK.

What made you want to get involved in transforming construction? And why is now the right time?

My passion for transforming construction probably dates back to my teens. I knew by then that I wanted to work in construction and I strongly felt that post-war construction was not responding to the needs of society – poor planning, poor design and leading to crime and urban decay.

Through my career, I've gradually pieced together the skills and experience that enable me to lead the change we need. I've worked as an engineer, architect, design manager and most recently innovation director at Skanska.

At Skanska, I was able to apply many of the techniques referred to as Industry 4.0 – interoperability of components, digital modelling, robotic assistance and distributed autonomous machines. I saw that they represented a fantastic set of tools to improve construction. We at UK Research & Innovation (UKRI) have this incredible opportunity now with the technologies, plus industry and the government support to fundamentally improve what we build and the way we build it.

How significant was it for construction to be recognised in the sector deals alongside industries like Life Sciences, Automotive and Aerospace as being essential pillars of the wider economy?

Construction industry turnover in the UK, at £110 billion, is bigger than aerospace and automotive combined, but has been trapped in a cycle of low innovation and low productivity. Other sectors have received generous government support that has contributed to revolutions in performance.

Construction is the last great unreformed industry, and the Sector Deal is enabling us to address that.

Partially due to the ongoing attention given to Building Information Modelling (BIM) and to site safety – the UK is already a world leader in construction performance – but there is the opportunity to do much more. The Sector Deal has brought the industry together as never before, aligning the aims of clients, suppliers, designers and the users of buildings. This could not have been done without the Sector Deal.

What are the key aims of the Transforming Construction Challenge?

The explicit aims of the challenge are to achieve the targets of the government's 2025 Construction Strategy, published in July 2013; namely a third reduction in construction costs, a 50% improvement in the construction trade balance, and 50% reductions in speed and carbon emissions.

In the process of addressing those targets, we are determined however to achieve much wider benefits – including higher wages, offsite fabrication jobs in neglected areas of the country, fewer vehicle

movements and less construction waste. The beauty of the strategy is that all these aims are mutually supportive.

What has been achieved so far?

We're making great progress. UKRI has so far provided £129 million of funding to industry with a further £36 million upcoming for collaborative research and development projects.

Funding is being used on over 100 companies of all sizes to work on solutions in collaboration with academia. Particular highlights include the SEISMIC project, which has developed standard frames for schools that will meet the targets listed above. These are already being procured at scale as part of the Department for Education's Generation 5 programme.

Another highlight is the Advanced Industrial Methods for the Construction of Homes (AIMCH) – a collaboration that will improve the delivery of over 35,000 homes per year.

What gives me confidence that we will continue to go from strength to strength is the support we've had across the industry. Many fantastic people that have joined the programme – my own core team, and the teams at the Active Building Centre and the Construction Innovation Hub.

Construction has long had an image of being slow to innovate and even resistant to change – how can that be overcome?

The main barrier to innovation in construction has been lack of integration. We are addressing that by supporting value-based procurement, developing digital configurator tools and demonstrating how the use of industrialised techniques across the value chain.

The Construction Innovation Hub will be the main driver for this. In order to encourage companies to collaborate, systems for the collection and sharing of data are being implemented, including the use of the internet of things. UKRI is also helping to develop artificial intelligence in construction, and the enhancement of skills, particularly in the digital arena.

Where do you think precision manufacturing and offsite construction can have the biggest impact?

Without doubt, precision manufacturing has a lot to offer all areas of construction, but the early impact will be seen with schools and housing. Schools will be a quick win because we have a secure pipeline of demand, a

clear line through to user benefits – in this case educational attainment – and a government client. We'll be using schools to demonstrate the improvements in efficiency and quality that can be achieved with a platform-based approach to construction. We want to get to the point where precision-manufacturing of buildings and infrastructure is so obviously better that it will become the default approach.

What is the role of BIM in improving not only how buildings are designed and put together, but their whole life performance?

BIM provides two things: accurate timely information and more certain outcomes. With BIM you have the opportunity to optimise both the production process and the way in which the users will interact with the building.

Each BIM project yields data that can be fed back into improving future projects. The modelling of the construction process enables the integration of the lean principles that have transformed value creation in other manufacturing sectors.

How do you see the future of BIM and the emergence of concepts like the digital twin?

The future of BIM will be based on what we call the Gemini Principles, created by the Centre for Digital Built Britain. These principles define how digital twins must be used for the public good, enable value creation and provide insight into the built environment.

Trust and openness are implicit, such that wide ranges of organisations can work effectively together to produce better buildings. The Transforming Construction programme will drive the uptake of the Gemini Principles across the industry, and really turbo-charge the process of innovation and continuous improvement.

Where do you see digital technology having the biggest impacts in construction going forward?

Longer term, it is through the application of machine learning (AI) that digital technology will have the greatest impact on construction. Today we navigate our way through construction projects like a driver who has a long journey to make, some knowledge of the route and an out of date map.

Sam Stacey

In the future, construction will be carried out as though we had a state-of-the-art Sat Nav to guide us. Continuously updated information will be fed into to the system, covering everything relevant to the success of the project. Powerful computers will process that data to provide clear guidance to everyone working on the project about what they should do at any given moment. We will always know exactly where we are going! ■

Sam Stacey
Challenge Director
UKRI Transforming Construction Challenge
Tel: +44 (0)1793 444 000
communications@ukri.org
www.ukri.org/innovation/industrial-strategy-challenge-fund/transforming-construction/
www.twitter.com/UKRI_News
https://www.linkedin.com/company/uk-research-and-innovation/
https://www.youtube.com/channel/UCkfOYxotdFTrxDKcfTV5tiA

A focus on smart energy green cities

Peder Vejsig Pedersen from European Green Cities tells us about the use of ATES technology with groundwater cooling and heating at Bispebjerg Hospital, Copenhagen

Under the coordination of the non-profit European Green Cities, with the support of the Danish Energy Agency's Smart Energy pool during 2019 and 2020, a targeted development and dissemination work on "Smart Energy" solutions will be carried out in several locations in Denmark, where the focus is on the widespread use of renewable energy in combination with optimised energy supply solutions that seek to utilise heat pumps in combination with so-called groundwater heat and groundwater cooling.

> "The yearly energy saving is 75% and more than 90% of stored heat during summer can be recovered."

I want to emphasise here that based on the expertise from the company Enopsol, and in a collaboration with the Copenhagen energy supply company HOFOR, as early as 2019, that an energy plant has been commissioned to utilise groundwater as a cooling medium in connection with the overall major redevelopment project for Bispebjerg Hospital in Copenhagen.

This so-called ATES * technology avoids the normal installation of large and noisy mechanical cooling systems on roofs, while at the same time saving 75% of the total energy consumption for cooling and heat. This is because it is possible to utilise the heat supplied through cooling by the groundwater during the summer season, using heat pumps in the winter, which then cover the peak of the heating needs during the coldest months. This also ensures that the groundwater temperature is not affected from year to year as it is possible to achieve a thermal balance for this.

The investment in the overall ATES solution has a positive user and community economy and pays home in five or six years. This can also be used advantageously for other hospital buildings and the like.

In addition to this project, there is also a collaboration with the company, Green Island, which is involved in the development of a fossil-free district at Vinge Nord in the Frederikssund municipality. You can find out more about this at http://www.greenisland.dk, as well as a dialogue on similar solutions using heat pumps and building-adapted solar cells for a new urban development area in Køge Nord, as well as renovation projects at Avedøre in the Hvidovre municipality.

Information about the above will be provided on the "Sustainable Cities and Buildings" association website and database and on the website.

* Aquifer Thermal Energy Storage (ATES)

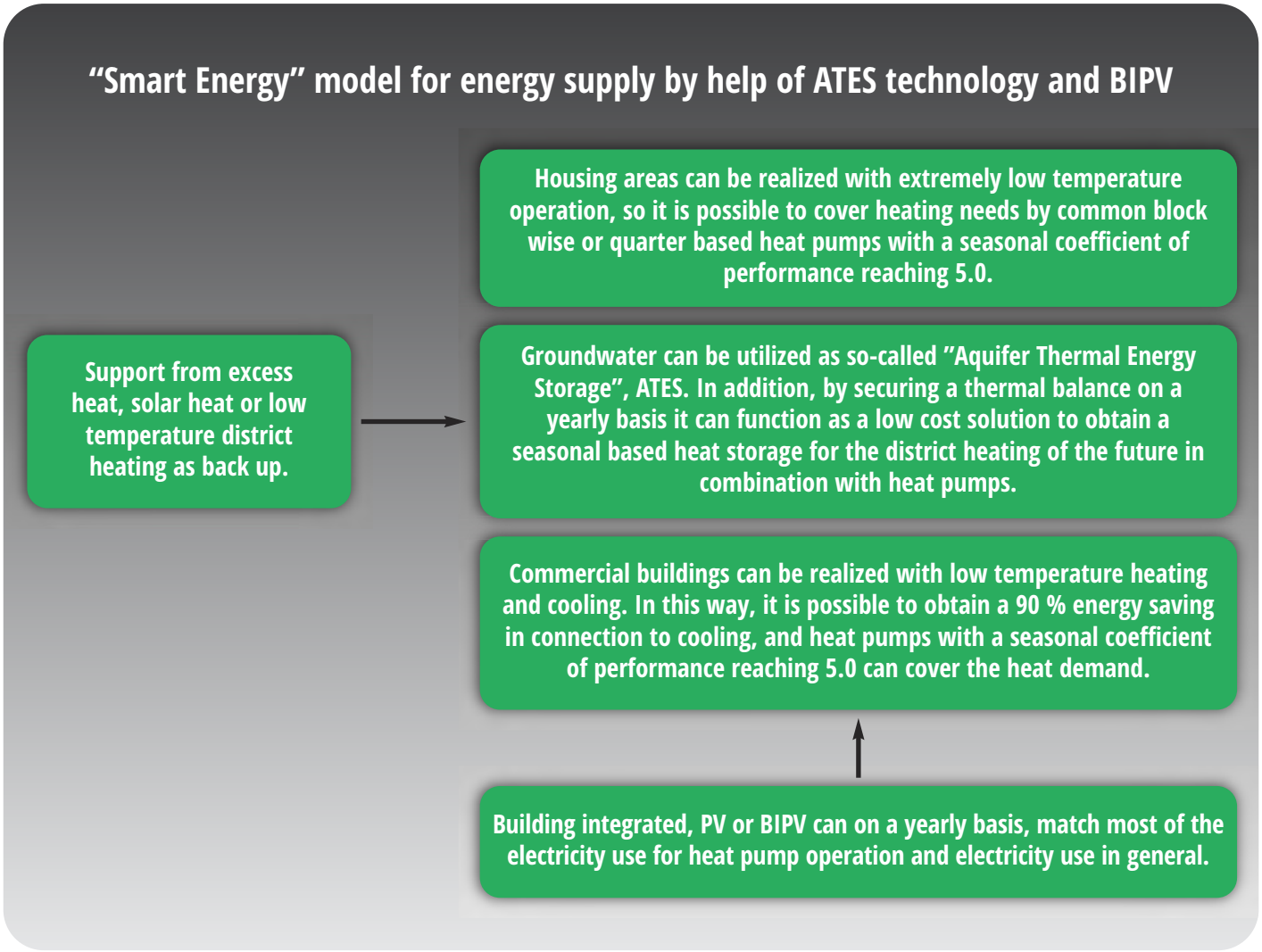
Peder Vejsig Pedersen

ATES groundwater cooling and heating

For the Bisperberg Hospital in Copenhagen was chosen to use Aquifer Thermal Energy Storage or ATES groundwater based cooling as a cheaper alternative than district cooling from HOFOR, the Copenhagen Energy Company.

The yearly energy saving is 75% and more than 90% of stored heat during summer can be recovered. 2 stage heat pumps from Sabroe is used (owned by Johnson Controls).

In winter, district heating is base load and heat pumps delivers the peaks. (Only from November to March).



In Denmark it has been proven that ATES systems can be used even quite near to drinking water pumping stations, but it is a demand that the ground water temperatures are never heated more than 0,5°C in the vicinity of this.

"The investment in the overall ATES solution has a positive user and community economy and pays home in five or six years. This can also be used advantageously for other hospital buildings and the like."

Besides an important effect has been that there has never been any net consumption of water, and there is no noise from the system. This can be compared to normal compressor cooling systems, which have a clear noise problem from the condenser in the roofs in summer.

From the ATES system developer Enopsol's point of view, the new and innovative SOLUS heating / cooling system, from Lindab with 19° - 24°C operation temperatures, is really interesting. Since there can be a perspective of avoiding the use of a large part of the heat pump operation, with its quite high electricity use, if the ground water temperatures can be raised somewhat in summer periods.

For a new city development area, Køge Nord south of Copenhagen it has been suggested to implement an advanced low temperature bidirectional district heating solution, which can be ideally combined with the above mentioned technologies, and new types of BIPV facades for a large commercial building development area.

European Green Cities

Peder Vejsig Pedersen
Senior Advisor, MSc
European Green Cities
Tel: +45 2046 6755
pvp@greencities.eu
www.europeangreencities.com
www.greenisland.dk
www.twitter.com/Vejsig

Marine energy test facilities accelerating commercial deployment: Importance of test facilities

Sarina Motmans from the West Flanders Development Agency POM, along with MET-CERTIFIED partners from Ghent University, the European Marine Energy Centre and the Dutch Marine Energy Centre underline the importance of marine energy test facilities when it comes to accelerating commercial deployment

The opportunities of marine energy are multiple and substantive: marine energy can play a significant role in the global energy transition, providing clean and predictable energy. It can help meet CO_2 reduction targets, boost regional economies and create new jobs. In this respect, test facilities are playing a crucial role in accelerating the deployment of marine energy systems, by reducing risks and raising capital for commercialisation.

Tidal power developer, Orbital Power, after having completed their extensive test programme at the European Marine Energy Centre in Orkney, are now building their 2MW commercial device. Tocardo, after having tested for years at the Dutch Marine Energy Centre facilities, are scaling up towards commercial units. And wave energy developers like Seabased, Corpower, Laminaria, NEMOS and Floating Power Plant are all using various test facilities to demonstrate installation and operations and prove the survivability and performance of their technologies. Increasingly, test facilities are also asked to independently certify performance, loads or fish friendliness of devices, in order to de-risks technology and, thus, provide a good level of confidence to insurers, investors and licensing authorities. Test centres are cooperating across Europe, exchanging experience and data and helping the sector to converge. Test centres also give an impulse to local and regional economies.

Best practices and recommendations

To help marine test facilities further develop their pivotal role, a best practice study on marine energy test facilities has been conducted as a part of the MET-CERTIFIED project[1]. This project aims to advance the marine energy sector through the adoption of internationally recognised standards and certification schemes.

The study consists of a state-of-the-art assessment of a number of marine test facilities and a comparison with test facilities in other sectors. Based on this analysis, strategic recommendations have been formulated regarding certification and standards, business models and marketing, as well as a call to action for policymakers to cooperate at local, regional and national levels, to simplify permitting and increase public funding for the sector.

Unlock marine energy's full potential

The potential of marine energy can only be unlocked when all stakeholders are involved, including governments at all levels. Despite the strong regional interest and supportive European Union (EU)-ambitions, the sector reports a lack of support at the national level. There is insufficient long-term vision and often low-carbon support is targeted at the nuclear, wind and solar industry.

More interest comes from the local and regional level since marine energy can boost local and regional economies, provide jobs and make coastal communities more attractive. At the EU level, significant instruments are available for the sector, underpinned by the strategic Blue Growth vision.

Simplify permitting

One obstacle all interviewed facilities were faced with is the complex and lengthy permitting procedures and high cost associated with the monitoring conditions. Developers see cheaper, faster and simplified consenting as one of the most critical benefits of using a test facility.

An effective approach would be to have fully pre-consented test sites. This means granting a permit for the

Circulation tank test facility IFREMER in Boulogne-sur-Mer, France

test facility that covers all types of testing activity and technologies that may access the facilities during the operational lifespan. The "Rochdale Envelope" allows a project description to be broadly defined, within a number of agreed parameters. In this case, the technologies and alternatives described in an environmental impact assessment cover a certain range so that the potential worst-case scenario is assessed. Conducting the assessment upfront and seeking site-wide consents can save valuable time and costs for the developers. Pre-consented test sites allow developers to focus on environmental impacts that are specific to their project and develop proportionate monitoring programmes which comply with consent conditions.

The monitoring experiences from test facilities can help regulators to define reasonable measures for permits and improve the sector's understanding of the potential environmental impacts associated with the technology. Most test facilities have built up close relations with the appropriate regulators, advisory authorities and stakeholders to mitigate any concerns and ensure monitoring programmes are relevant. In order to support these relationships, test facilities have adopted best practices including: in-depth consultation during the environmental impact assessment and continuous stakeholder engagement exercises during the development of the test facility and throughout the operation.

Increase public funding

Another observation from the study is that public funding for both test facilities and marine energy developers is vital to help develop this promising sector. All interviewed test facilities rely on public funding in one way or another. Most are not-for-profit entities, supported by both public and private partners. Usually, test facilities need significant early-stage funding support and are fully or partially state-owned. Once operational, the operations and further development are based on a combination of EU, state and private funds.

In addition to the public funding of the test facility, continued funding and support to the marine energy industry and specifically developers is crucial. Developers face challenges in securing both public and private financing for early-phase projects, especially those with significant technology risk and capital intensity. This gap in commercial-scale financing hinders advanced energy technologies to become marketable. In addition, most of the support is intended for the test phase, yet the greatest costs and risks are related to marine operations, resulting in a market getting stuck just before the commercial phase.

Best practices show that collaboration through European programmes that provide funding for testing is beneficial. Establishment of similar funding programmes could help in the development of marine energy.

The study carried out under the MET-CERTIFIED project, calls for policymakers at all levels to give marine energy the attention it deserves and help unlock its potential by facilitating consenting procedures and increasing public funding for its testing. The complete study can be consulted at http://www.met-certified.eu/downloads (D2.8.1). ■

1 MET-CERTIFIED is funded by the European Interreg 2 Seas programme and co-financed by the European Fund for Regional Development (ERFD). Financial support is also provided by the Ministry of Economic Affairs in the Netherlands, the Province of South-Holland and North-Holland and the Belgian Province of West Flanders.

Sarina Motmans
West Flanders Development Agency POM
www.pomwvl.be

With contributions from MET-CERTIFIED partners:

Dutch Marine Energy Centre
Peter Scheijgrond,
Project Coordinator MET-CERTIFIED
peter@dutchmarineenergy.com
www.dutchmarineenergy.com

Ghent University
www.ugent.be/en

European Marine Energy Centre
www.emec.org.uk

The processes, vulnerabilities and dangers posed by cryptocurrencies and the 51% attack

Marc Laliberte, Senior Security Analyst at WatchGuard Technologies, looks at the processes, vulnerabilities and dangers posed by cryptocurrencies

Cryptocurrency entered mainstream consciousness in December 2017 when Bitcoin's value was nearing what would become its all-time high, which was just shy of $20,000 per coin. Others, called altcoins, were buoyed by this rising tide and reached previously unfathomable prices. People even started to take out home equity loans to buy into the craze, quite likely to their financial advisers' dismay.

Their popularity was based on the fact they were billed as a safe, albeit not necessarily stable, payment platform. Thanks to strong cryptography, in theory, it should be impossible for someone to be able to manufacture their own 'coins', steal someone else's, or reverse any transactions. And in most cases this is true, but there are other ways than breaking cryptography to steal them.

In January this year, one attacker exploited a flaw found in the majority of cryptocurrencies and made off with $1.1 million in Ethereum Classic. This so-called '51%' attack highlights a critical vulnerability which has been present since the technology's inception and which will, over time, only get worse.

So, what exactly are these cyber currencies and how do they work in financial transactions?

Bitcoin was first launched about ten years ago and was the first example of cryptocurrency. It used a blockchain as a distributed public ledger. This is a database which is collectively shared and synchronised across multiple sites and allows money transactions to have 'witnesses' and without the use of any centralised bank. A 'distributed' ledger contains hundreds of thousands of 'nodes' (a connection device), which all participate by validating and storing the ledger. Anyone can take part in the management of the blockchain by forming or 'spinning up' their own node. Other examples of cryptocurrencies include Ethereum, as well as the privacy-focused Monero and the speed-focused Litecoin.

How transactions are added

Most cryptocurrencies use a system called 'Proof of Work' (PoW) to build a consensus on what the correct blockchain is. The process of adding blocks of transactions to this chain is called mining and the nodes which participate are called miners.

This is a simplification, but at a high level the process operates in the following ways:

First, a mining node receives transactions and validates them to make sure there is no double spend, for example, spending the same funds twice in different transactions. The nodes then bundle up a number of transactions into a block. At the end of the block, they add a transaction which gives them an amount of cryptocurrency as payment for their work. Finally, the node begins trying to mine the block into the blockchain. In the PoW process, this intentionally involves very difficult maths which is computationally expensive. Miners compete against each other to solve the problem which adds their block and the first miner to solve the maths gets a reward of some coins.

The miner who finds the solution to the maths problem 'announces' their mined block into the network and other nodes then verifies the solution and the new block is added to the chain.

'Forks' are created when two different miners come up with two different but acceptable, solutions and then mine two valid blocks. Over time, one will become longer as the majority of nodes add blocks to it and the longest one is accepted as the correct version and the remaining one is abandoned.

PoW blockchains rely on the honest majority, meaning that a majority of mining power must follow the intended blockchain's mining behaviour. For large cryptocurrencies like Bitcoin, with up to hundreds of thousands of nodes, it is prohibitively expensive to amass enough computing power to control this majority under either a single person's or organisations' control, which keeps the ledger safe from attack.

Enter Ethereum

This altcoin was introduced in 2015 and expanded the idea of a public transaction ledger from just distributed financial transactions to distributed computing.

This is where nodes on the network participate in a decentralised virtual machine and use scripted functions to build fully distributed applications.

Over the last four years, developers have built applications on the Ethereum network from cat-trading game, CryptoKitties, to an investment platform called the Decentralised Autonomous Organisation (DAO).

A year after Ethereum was introduced, however, an attacker exploited a vulnerability in the DAO's underlying code to siphon off $550 million in Ether, the cryptocurrency which drives the Ethereum blockchain.

Because blockchains are immutable meaning that fixed and invariable transactions cannot be reversed, the only way to reverse this was to 'hard fork'. This fork essentially went back in time, negated the attacker's transactions and created a new version of the blockchain.

It's highly controversial to do this because it goes against one of the core tenants of the technology, its immutability. But due to the scale of the hack, a majority of the nodes agreed to fork so the majority rule succeeded and Ethereum continued on its new branch.

Yet from this, because a substantial number of nodes disagreed with the hard fork and continued on with the original chain, hack included, Ethereum Classic came about and the pair still exist as separate but related chains.

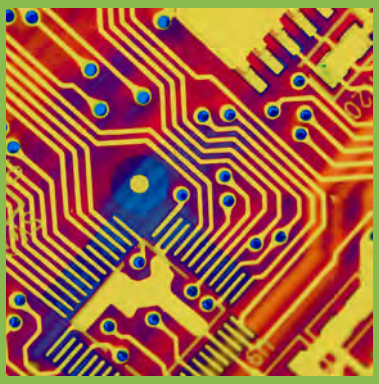
The 51% attack

Cryptocurrency values began to crash last year with many altcoins becoming unprofitable. This was due to

Continued on page 399 →









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the fact that mining them isn't free. Mining nodes convert electricity into computation power in order to solve the complex maths problems involved, so if the cost of the electricity outweighs the rewards earned for successfully mining a block, it doesn't make any financial sense to keep on with that particular currency. This, in turn, will lead to a drop in mining power, meaning fewer participants and less of a majority, which then led to the January 7th attack when an attacker exploited the drop in power.

The attacker sent several transactions worth from tens of thousands to hundreds of thousands of dollars in Ethereum Classic to several different wallets, which are a device, physical medium, programme or service, which stores the public and/or private keys and can be used to track ownership, receive or spend the cryptocurrencies.

They then obtained 51% of the mining power so that they could exclude transactions from their new version of the blockchain and eventually overtake the original version of the blockchain to become the 'real' accepted version.

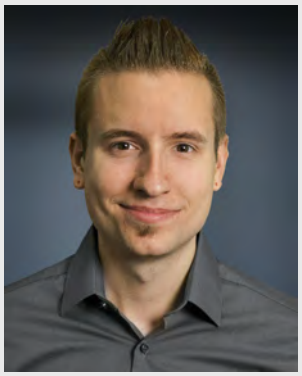
Basically, the attacker created a new reality in which they never actually sent their Ethereum Classic to the exchanges, allowing them to keep both their Ethereum Classic currency and the alternative cryptocurrency like Bitcoin, that they traded for before launching the attack.

In summary, a 51% attack allows the hacker to double-spend their funds. In this case, spending it once to purchase a different cryptocurrency and then regaining it to spend again. The recipient of the original transaction has their funds stolen when the blockchain is reorganised and the transaction removed. One of the victims of this attack, Gate.io had $100,000 worth of Ethereum Classic stolen and Coinbase about $1.1 million.

Are major cryptocurrencies vulnerable?

In technical terms, all the cryptocurrencies that use PoW are vulnerable to a 51% attack, including Bitcoin, Ethereum and Monero. Practically, the computing power needed to do this is astronomical. For this attack, mining power from a cloud provider like NiceHash could have been bought.

At the time of the attack, the perpetrator would have needed to maintain 8TH/s (8,000,000,000,000 hashed per second) and NiceHash charges about $15,000 per day for 1TH/s, so this could cost $120,000 for a full day, which is enough time to execute a double spend of this type.



Marc Laliberte,
Senior Security Analyst at
WatchGuard Technologies

Therefore, these attacks are a serious risk to smaller cryptocurrencies as it is economically feasible for an attacker to rent enough mining power to take many of them over. One of the things holding them back, however, is that they are almost guaranteed to crash the value of a currency if their value is already smaller than Ethereum Classic.

What are the fixes?

Although larger cryptocurrencies may all but be immune to attacks like these, it isn't stopping changes being implemented, which can help impede them. An example is Ethereum, as well as others, that are moving towards a process called Proof-of-Stake, which mitigates attacks by destroying the funds the attacker is trying to steal.

Smaller currencies could still be in trouble though because while people still put funds into new and cheaper ones in the hope of striking gold during a surge in value, there are still serious risks. Cryptocurrencies are still essentially in the realms of the Wild West and should, as a result, be treated with careful consideration. ■

Marc Laliberte
Senior Security Analyst
WatchGuard Technologies
Tel: +44 (0)203 608 9070
uksales@watchguard.com
www.watchguard.com
www.twitter.com/watchguard

Data with evidence: Building the supply chain for data

Steven Sprague, Cofounder and CEO of Rivetz shares his thoughts on the importance of protecting the supply chain of data, ensuring all transactions are purposeful, intended and compliant

The advent of digital is rapidly creeping into every aspect of our daily lives and social relationships. Digital has empowered millions of users to experience a new model for the exchange of information. The future is decentralised and the technologies of blockchain, mobile and Internet of Things (IoT) will touch very aspect of our digital life. Emerging markets such as the requirements for Smart Cities, Finance, Healthcare, etc. cannot be infected by "FAKE" data. Data quality needs to join the same priority as water quality and power reliability. The digital revolution has brought with it a future with trust and history. The reliability and quality of data will underpin the value of all the other systems.

One of the biggest issues with today's digital services is that a device that creates data is generally unknown, because the devices lack strong machine identity or because the infrastructure enables weak identities. Billions has been invested in USER identity but not the health and integrity of the device that creates the data. It is not enough to just protect critical information in the operating system. The device needs to aggregate the evidence to ensure that the transaction reflects the user's intentions.

The current models are all built on the foundations of network architecture where compliance and security are verified at the point of access. The challenge is to enable a shift from a centralised compliance model where a third party authorises transactions after they are submitted, to a decentralised model where the user, third party services and their device can determine compliance before a transaction is submitted.

The shift to a device-centric trustworthy computing model has been proven to work. The Point of Sale terminal model uses the terminal and smartcard together to form secure instructions for the global payments network. The deployment of chip cards and secure terminals in Europe over the last 15 years has driven fraud and the actions by bad actors to historical lows for physical presence transactions in bricks and mortar.

The e-commerce security model of only card numbers and security codes has seen continued growth in fraud rates around the world, demonstrating that big data and continuous monitoring is not a viable long-term model. The optimal approach is to pre-validate the cybersecurity controls and compliance before a transaction is committed. The validation can then be bound to the data providing the proof a known device in a known condition produced the data.

The core of the data quality problem is anchored in the fact that the mobile apps and browser services markets are built on a foundation of "any device" with username and password. The compromise of passwords, a well know industry problem, has resulted in increasing fraud. However, Trusted Execution technologies used in SIM chips, Smart Cards, PCs, smartphones, cable boxes, and other devices have proven to be resilient for managing subscribers and these technologies are standardised in billions of devices today.

The challenge of transactional security is not just assuring the proper identity of the originator of a transaction, but also that the instructions associated with that transaction are intended by the originator. Cyber security technology enables the assurance that a transaction created was the transaction intended and includes not just the signing of the message with an identity but also assurance that the sender verified and consented to the instructions being sent. A secure instruction requires that the sender and receiver are both confident that the identities and cybersecurity controls were used as intended, and that the message wasn't changed after being sent.

The Rivetz Solution

The 4th Industrial Revolution requires that the user protections and transactional security exceed any solution available today. Presently, hooking a blockchain to an exchange or a

lightbulb to a phone that authenticates via username and password will not meet the needs of billions of users. The challenges of identity, control, privacy, compliance and ease of use must all be addressed. The data must travel with a mark of quality to assure the data is real. The principles of decentralised operation must be preserved to protect the user's privacy and control. Users must own their private keys to allow for choice.

Rivetz is built on the foundations of data and device security standards established over the last 20 years. Rivetz combines the technologies and standards of Trusted Execution, Global Platform, Trusted Computing, NIST Information Assurance, Payment Security Directive 2, GDPR and many others.

Rivetz has architected and constructed The Rivetz Network, a collection of cyber security services and policies that are available to applications. Using Trusted Execution technology, Rivetz protects critical security information and enables users, regulatory parties, or owners of specific digital assets to dictate the required policies which must be evaluated for compliance before transactions are submitted. In addition to Rivetz developed services and policies, we enable third party providers to also offer cyber services through our provisioning and settlement capabilities of our network.

Rivetz has built a key partnership with Telefonica ElevenPaths to research and develop next generation protections for the owner's keys and instructions. The goal has been to leverage the existing hardware that is already present in modern mobile devices. Rivetz uses both the TEE and SIM to protect our private keys – introducing the Dual Roots of Trust. This enables remote over the air control of digital assets independent of physical possession of the device.

As our mobile devices have become more important to our everyday lives and contain so much of our personal and private data, we need better ways to protect ourselves. The keys to the solutions needed lie in the roots of trust that already exist on billions of mobile platforms and the emerging partners and policy services that are part of The Rivetz Network, ensuring a safer, more secure and simpler experience.

rivetz

Steven Sprague
Cofounder and CEO
Rivetz
sales@rivetz.com
https://rivetz.com
www.twitter.com/rivetzcorp

The use of blockchain in the financial, public and other sectors

Guy Robson, Senior Associate and Elliott Fellowes, Associate at Signature Litigation, discuss the use of blockchain in the financial, public and other sectors

Blockchain has come a long way in the decade since Satoshi Nakamoto proposed Bitcoin as an alternative currency following the 2008 financial crisis. Blockchain is essentially a form of distributed ledger, in which each new entry on the chain is cryptographically linked to the previous entry. The use of cryptography to link each entry on the chain to that preceding it should mean that the chain is a true and accurate representation of the transactions which have taken place and which cannot be altered.

A variety of different products, no longer limited to alternative currencies, are now being built and developed on blockchain, perhaps most notably in the financial and public sectors. As a result, the use cases and applications of the technology have continued to grow at pace. While there remain a number of challenges to overcome in order for blockchain to obtain mainstream adoption, the potential is clearly there to drive efficiencies in sectors other than the financial and public sectors.

In terms of the financial services sector, where previously blockchain might have been the realm of start-ups, traditional financial institutions are now experimenting with blockchain-based solutions. Blockchain has the potential for banks and other financial institutions to transfer value instantaneously around the globe, whilst incurring significantly less expense in doing so (for example by reducing the need for intermediaries) as compared with settlement systems currently used in most mainstream finance.

A number of banks are now heavily investing in blockchain, including JP Morgan Chase ("JPM"), which has developed the Interbank Information Network ("IIN"), a peer-to-peer network, in order to assist banks with cross-border payments. The technology powering IIN is Quorum, a permissioned version of the Ethereum blockchain. Since its launch in 2017, around 75 of the world's largest banks have signed up to IIN and JPM hopes that this will increase efficiencies through reduced fees and less delays as a result of member banks exchanging information in real time to verify and approve payments.

Whilst there are obvious benefits associated with blockchain in terms of speed and immutability of the ledger, there are also risks, perhaps notably (and somewhat ironically) the potential for fraud. For banks, a potential issue in this regard is regulatory compliance when dealing with customers who want to invest in crypto-assets. How will banks determine the source of funds of a customer when those funds are held in assets on an anonymised blockchain ledger such as that of Bitcoin? If the aim is to integrate blockchain and crypto-assets into traditional financial frameworks, banks and financial institutions will need to work closely with their regulators to maintain adequate and acceptable compliance. In the UK, the FCA's "sandbox" allows firms to test products in a controlled environment before applying for authorisation from the regulator, allowing firms and the regulator to work closely when developing blockchain-based products. The FCA has said that it has accepted a number of firms which will be testing propositions relating to crypto-assets into the "sandbox".

Just as with the financial sector, blockchain has the power to revolutionise the public sector. In the UK, for example, HM Land Registry is seeking to utilise R3's blockchain platform as part of the "Digital Street" research and development programme. The aim is to explore the potential benefits of blockchain to understand how distributed ledgers and smart contracts could improve the efficiency of property transactions by developing a faster, more secure and cheaper land

Guy Robson, Senior Associate

Elliott Fellowes, Associate

registration process. The idea is that land property registers could be built upon a blockchain, making investigations into title far easier and potentially linking the title to any charges created over the property, such as digital mortgages. This would also allow for immediate transfer of title, without the need for the registry to be updated separately.

A further public sector use case for blockchain is the reporting and reconciliation of intragovernmental transactions. Such transactions are common in federal systems, such as the United States. However, they also occur in non-federal systems, for example, transactions between government agencies or between regional and central government functions. Real-time settlement and an accurate, immutable ledger recording transactions could alleviate some of the onerous reporting requirements, minimising errors and increasing transparency in relation to the utilisation of government resources.

With new technology comes new issues and the public sector use cases above are no exception. For example, whilst a blockchain-based ledger may be fixed, there remains the possibility for fraud during the property purchase or transaction. This raises the question of what would happen if a fraudulent purchaser of a property is entered as the owner on the Land Registry's blockchain. Blockchain records are intended to be immutable - removing the need for a middle-man is a large part of blockchain's attractiveness. If transactions need to be rectified, due to fraud or some other reason, how does one easily go about this? What is the nature of the "damage" suffered by the wronged party and what order could a court make in order for an aggrieved party to be properly compensated?

These examples are just some of the potential uses of blockchain technology. There are numerous other sectors also investing in the technology, such as the art world which is considering blockchain solutions to prove immutable provenance of artworks or charitable organisations considering crypto-donations as a more efficient and transparent means to raise and distribute funds. Whilst the future is bright for blockchain, there remain risks as with any new technology and increased legal certainty for the Court and the government will assist in the continuing development of the technology. ■

Guy Robson
Senior Associate

Elliott Fellowes
Associate

Signature Litigation
Tel: +44 (0)20 3818 3500
info@signaturelitigation.com
www.signaturelitigation.com
www.twitter.com/SignatureLitLLP

Blockchain: The fight against financial crime

Dave Elzas, CEO, Geneva Management Group discusses the role of blockchain in the fight against financial crime: could it prevent another Bernie Madoff, who pled guilty to the largest Ponzi scheme in world history?

In early 2009, Bernie Madoff pled guilty to the largest Ponzi scheme in world history and the largest financial fraud in U.S. history. Over the course of nearly three decades, the financier turned career criminal had stolen billions of dollars from investors by way of deceit and using fraudulent financial reporting. While no one has managed to eclipse Madoff in the intervening years, fraud remains a widespread problem in the finance industry.

In the UK alone, it's estimated that fraud costs the economy £110 billion a year, with the global economy suffering losses to the tune of £3.2 trillion annually.

If authorities are to seriously tackle this scourge and put an end to any future Madoffs, they need to invest massively in technology, and blockchain in particular.

Caught in the past

The trouble is, most authorities responsible for detecting and catching fraudsters are using yesterday's technology.

In a 2016 op-ed published by The Guardian, former U.S. congressional representative Randy Hultgren points out that the regulators investigating Madoff were stuck using the same pen and paper technology as their 1930s forebears. As a result, repeated fraudulent reporting slipped between the cracks, despite six complaints about his firm having been lodged between 1992 and 2008.

Meanwhile, a recent article in Bloomberg points out that the US$9-trillion business of financing global trade is still largely paper-driven, making it susceptible to forgery at every point in the value chain.

By contrast, the criminals these regulators are supposed to investigate and catch, have embraced digital technology and use it to take their illicit activities to new heights.

Whether it's using up-to-the-minute designs to phish bank customers or sophisticated algorithms to skim

minuscule amounts off billions of global transactions, today's financial criminals are tech-savvy, increasingly difficult to detect, and capable of more sophisticated crimes than at any other point in history.

Banking on blockchain

That does not, however, mean that the fight against financial crime is lost. Regulators, banks, and the financial transaction giants whose business depends on correct verifiable financial data and accountability can fight back.

Doing so means abandoning current practises, which have so far proved ineffectual to the benefit of the Bernie Maddofs of the world.

Instead, regulators and financial industry players alike should focus their efforts on blockchain. Its system of cryptographically-linked, unmodifiable entries are ideal for the financial space.

Because records cannot be altered or deleted, hiding illicit financial movements becomes almost impossible.

There are several other factors which make blockchain ideal for fighting financial crime. These include:

- The technology allows independent verification reliance on third parties.
- Transactions are recorded in immutable chronological order.
- Records stored in the blocks are contained in millions of computers participating in the chain; making fraud logistically much more difficult.
- The blockchain is secure and transparent.
- Every transaction can be tracked on the blockchain.

These characteristics make blockchain useful for more than just tracking financial transactions. Blockchain-enabled smart contracts, for example, could go a long way to eliminating the forgery that bedevils the financing of global trade.

Embracing early adoption

Admittedly, some blockchain applications have had teething problems, as is to be expected with any new technology. However, as the global usage of blockchain will increase, so will its accessibility and reliability.

Certainly, none of the incidents which have impacted blockchain-enabled applications should deter regulators, banks and other players in the world of global finance from becoming enthusiastic early adopters of the technology.

Dave Elzas

Banks are already embracing blockchain at a much faster rate than expected, with some (including major players such as UBS) implementing blockchain labs to explore potential new applications for the technology.

It should not only be banks that embrace blockchain in isolation. Regulators, authorities and other secondary players also have a role to play. Landed registries, companies worldwide and any official registration agencies would benefit from the cost effectiveness, automation and accuracy of blockchain. More importantly, these various players all need to work together in standardizing processes and protocols.

In some places, this kind of forward-thinking collaboration is already in place. The Canton of Geneva's support of the Geneva Fintech Association (which plays a pivotal role in educating and advocating for blockchain) is a good example of what's needed around the globe.

These kinds of initiatives need to become far more widespread. It's time to stop patching up leaks and start putting in better pipes. ■

Dave Elzas
CEO
Geneva Management Group
Tel: +971 4 447 00 44
www.gmgfinancial.com

Share Internet Data Ltd (SID) expands its mobile network to include the unbanked with its LDJ Digital app

Jose Merino, CEO of LDJ Digital explains here how Share Internet Data Ltd (SID) is expanding its mobile network to include the unbanked with its exciting LDJ Digital app

When the United Nations declared basic access to the internet as a human right in a 2016 resolution, Share Internet Data Ltd saw this as a gateway to leverage and create an app that will advance the democratisation of internet access.

Following a successful launch, the SID platform has now expanded to include also the unbanked through its partnership with LDJ Capital Inc to create LDJ Digital, the digital banking solution based on the SID technology of free internet access.

The architecture built on the SID technology is the core foundation that laid the groundwork for the possibilities in digital banking central to the principles of LDJ Digital.

> "With free internet accessibility, LDJ Digital truly differentiates itself from other mobile banking services and platforms. The SID technology and blockchain technology supporting LDJ Digital make it the most accessible and affordable option for the unbanked segment of the society."

To better understand how the SID technology improves net-neutrality, picture this: the smartphone personal hotspot or tethering function is controlled by the SIM mobile network provider and as such, this feature requires the person in need of internet to obtain the password from the other device of an unknown owner. In contrast, the SID patented technology uses its own proprietary solution where the SIM mobile network provider has no access and as such, cannot switch it off or limit the speed. What the SID technology does is create a random one-time-use password between the two nearby SID users' smartphones – the provider and the receiver – and presto! Internet data is shared seamlessly.

With free internet accessibility, LDJ Digital truly differentiates itself from

other mobile banking services and platforms. The SID technology and blockchain technology supporting LDJ Digital make it the most accessible and affordable option for the unbanked segment of the society.

It's tagline "Mobile banking for your generation", that says it all. It is for the digital generation – their money and other cryptocurrencies. Done their way. All fiat currencies, as well as digital currencies, are easily accessible and tradable – paying no fees while earning rewards every step of the way. It also acts as a personal debit card that one can use to spend on payments as well as in-store and online purchases.

Jose Merino, SID Chairman and LDJ Digital CEO, says: "Free access to the internet opens the floodgates of access to a host of other global resources. Financial inclusion is one of the logical results of this. The SID ecosystem is set-up to support a robust community that embraces educational, social and financial inclusion among others."

SID allows its European users, in the EEA area, to subscribe now to the LDJ Digital waitlist. Register at: https://ldjdigital.com

Priority access will be given to the first respondents in the waitlist when the First digital bank app launches this 2019 and members can create their online banking account in under three minutes. This will give them access to a digital online bank account supporting multiple currencies like EURO, USD, GBP and multiple cryptocurrencies like BTC, ETH, LTC, etc. with an associated Debit Card for shopping globally in stores or online.


Jose Merino

"Free access to the internet opens the floodgates of access to a host of other global resources. Financial inclusion is one of the logical results of this. The SID ecosystem is set-up to support a robust community that embraces educational, social and financial inclusion among others."

AGRILEDGER

ldj digital

Jose Merino
CEO
LDJ DIgital
JoseMerino@LDJdigital.com
https://LDJdigital.com
www.twitter.com/ldjdigital/

The Cyber Skills Immediate Impact Fund

Matt Warman MP, Cyber Security Minister at the Department for Digital, Culture, Media and Sport, tells us about the Cyber Skills Immediate Impact Fund and how it is quickly increasing the number and diversity of individuals entering the cyber security profession

The UK tech sector is one of this country's success stories and continues to go from strength to strength. As our economy depends more and more on digital technology and connectivity, we are stepping up our approach to cyber security to meet the demands of the present and plan for the future.

Almost every day, there are new reports of cyber-attacks and data breaches and the threat is on a global scale. That's why we need a skilled and diverse workforce to match the challenge ahead. Our Cyber Skills Immediate Impact Fund (CSIIF) is an example of an initiative we expect to make a real difference going forward, quickly increasing the number and diversity of individuals entering the cyber security profession. We recently launched the third round of funding. Training providers will be able to bid for up to £100,000 to work with employers and design training programmes which retrain a diverse range of people for careers in cyber security.

The Fund has already helped over 400 people benefit from training opportunities, with twelve training initiatives receiving support so far. One example is the 'Cyber Ready' project sponsored in the first round. This project run by CompTIA identified and helped thirty individuals in London and the North West of England on the road towards a recognised industry qualification. Graduates from the programme now have jobs in cyber security roles in organisations including Lloyds Banking, Amazon and the NHS.

The Fund is designed to stimulate the cyber security retraining system so that the industry can see this type of initiative is a valuable pipeline for developing and finding talent. In the future, we hope that successful initiatives will help to grow the UK's network of training providers working to help meet the immediate need for cyber security skills. CSIIF is just one of the ways government intervention is inspiring the next generation of cyber security talent through its 'Cyber First' initiatives. Other programmes and competitions, including Cyber Discovery and our range of Cyber First courses, are also encouraging young people to explore a career in the industry.

Through our National Cyber Security Strategy, we are investing £1.9 billion to help millions of people and organisations become more secure. We recently announced that the Institute of Engineering and Technology will be the lead for the new UK Cyber Security Council, which will help to make cyber security a well-structured and easy to navigate profession.

All of these measures will help to ensure we have skilled people from a range of backgrounds represented across the profession, increasing our resilience for the future. Our digital economy is an absolute priority. We want to make the UK the best place in the world to start and grow a business and good cyber security and the workforce to match will enable companies to seize the many opportunities of a connected world. ■

Matt Warman MP
Cyber Security Minister at the Department for Digital, Culture, Media and Sport
enquiries@culture.gov.uk
www.gov.uk/government/organisations/department-for-digital-culture-media-sport
www.twitter.com/DCMS

Closing the digital skills gap: Three steps for business and government collaboration

We all have a responsibility to close the skills gap, but what are you going about it? Here, Ramkumar Chandrasekaran, HR Director, UK & Ireland at Tata Consultancy Services shares three steps for business and government collaboration

Looking back on recent industry announcements, one thing that really stands out for me is that the government will invest £153 million into quantum computing technology. At the same time, global tech companies pledged to invest more than £1 billion in the UK. At first, we may feel a sense of relief at this news. But when you think about it, more needs to be done before we get too overjoyed, as really, this is the necessity and the minimum.

Investment needs to come in more ways than one and funding, no matter how large, is just the start. This is especially true when it comes to national issues such as the digital skills gap.

The good news is that there's a strong appetite to address the widening skills gap and awareness of the importance of upskilling in IT. In fact, 61% of businesses strongly agree that the government needs to better address digital skills gaps, according to a report from TCS and CBI. In addition to investing financially, 93% of tech firms are acting on their responsibility to address the digital skills gap. The main ways that they are doing this is through hiring more external talent


Ramkumar Chandrasekaran

from the UK, partnering with small and medium-sized enterprises (SMEs), suppliers or contractors and by organising short courses, among other things.

> "Closing the skills gap is too big a job for one government, or one business or one school. It must be a collaborative effort. By pulling in expertise from the supply chain, local SMEs, Local Enterprise Partnership (LEP) and perhaps even competitors, companies improve their internal digital skills strength and can train up the next generation of talent."

Future growth isn't only dependent on money, it's is about a longer-term, broader pledge for change. With this in mind, let's look at how businesses need to work with the government to better enact change in the industry, to help close the skills gap:

Know your vision

Knowing where you want to end up is essential in determining the path you take to get there. Companies that have a clear vision to improve digital skills, whilst knowing their long-term success relies upon it, will better prioritise the bespoke skills needed to make progress.

If guidance is needed to help find that direction, they can do so by paying attention to government reports such as the Tech Competitiveness Study. By seeing what the government is prioritising, businesses can follow suit.

Collaborate as much as you can

Closing the skills gap is too big a job for one government, or one business or one school. It must be a collaborative effort. By pulling in expertise from the supply chain, local SMEs, Local Enterprise Partnership (LEP) and perhaps even competitors, companies improve their internal digital skills strength and can train up the next generation of talent.

Support the next generation

The next generation is the first digitally native generation. We should be adapting to embrace that fact. While the government is rolling out initiatives such as mandatory coding in primary schools, businesses can build on these foundations and offer more in-depth teaching to pupils through educational outreach. After all, some of the rarest and brightest minds in this field are in business, not academia and we must share that expertise.

Despite the concerns about digital skills, businesses and government are clearly on the right trajectory to turn this around. Each party brings different skills, resources and expertise to the table so now is the time to take the steps towards greater collaboration and ultimately give us a reason to celebrate resolving the digital skills gap. ■

Ramkumar Chandrasekaran
HR Director, UK & Ireland
Tata Consultancy Services
www.tcs.com
www.twitter.com/TCS

Building an advanced computing ecosystem for 21st-century research and education

Here, four experts from the National Science Foundation reveal their thoughts about building an advanced computing ecosystem for 21st-century research and education

We are witnessing an inflection point in our Nation's research and education enterprise: The unprecedented availability and scale of data and computation are transforming all fields of science and engineering (S&E) and the technology landscape enabling scientific and engineering discovery and innovation is evolving rapidly. Indeed, advanced computing systems and services are now integral to enabling advances across all fields – and ultimately ensuring the Nation's continued leadership and competitiveness.

In support of evolving S&E drivers and leveraging a constantly-changing technology landscape, the Office of Advanced Cyberinfrastructure (OAC) within the National Science Foundation (NSF) provides broad access to an agile, integrated, robust, trustworthy and sustainable cyberinfrastructure (CI) ecosystem for the Nation's researchers and educators.[1] NSF's CI investments align with national priorities for future computing systems, as outlined in the National Strategic Computing Initiative (NSCI).[2] Central to NSF's vision is a balanced ecosystem (as illustrated in Figure 2) that effectively supports a broad and diverse set of requirements, users and usage modes. It increasingly blends translational computational research and cyberinfrastructure, while integrating innovations from the private sector. Furthermore, it includes crosscutting coordination, allocation, measurement and user support services and is complemented by the other components of the CI ecosystem including software and data services, networking, cybersecurity and learning and workforce development.

Here, we describe some of the key pillars and the associated activities that OAC has been spearheading over the last year, in support of this ecosystem.

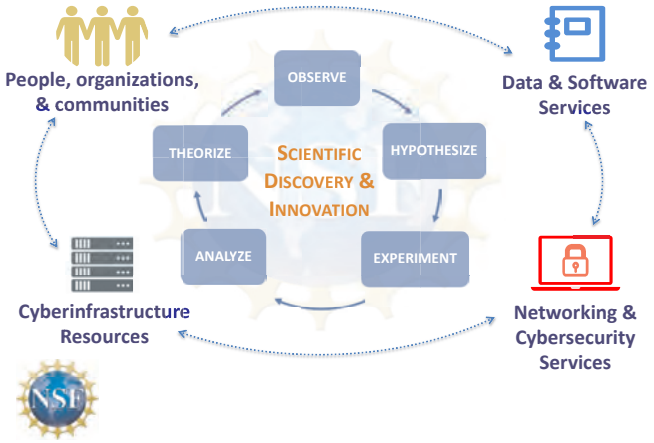


Figure 1: The NSF-funded cyberinfrastructure (CI) ecosystem – NSF has embraced an expansive view of CI motivated by science and engineering drivers and an evolving technology landscape.

Leadership-class computing

So-called "leadership-class computing" constitutes highly specialised computation and data analytics instruments providing the extreme-scale capability to support S&E research and education that would simply not be possible otherwise. With support from NSF, the Texas Advanced Computing Center (TACC) at the University of Texas at Austin (UT Austin) recently launched the **Frontera** system.[3] This leadership-class computing system is the most powerful supercomputer ever deployed on a U.S. academic campus and will support some of the Nation's most computationally challenging science applications. Frontera ranked fifth in the June 2019 edition of the Top500 supercomputers list – but the system is specifically designed for sustained performance across all kinds of S&E job classes. The system began accepting early S&E research users in May 2019 and will enable advances ranging from

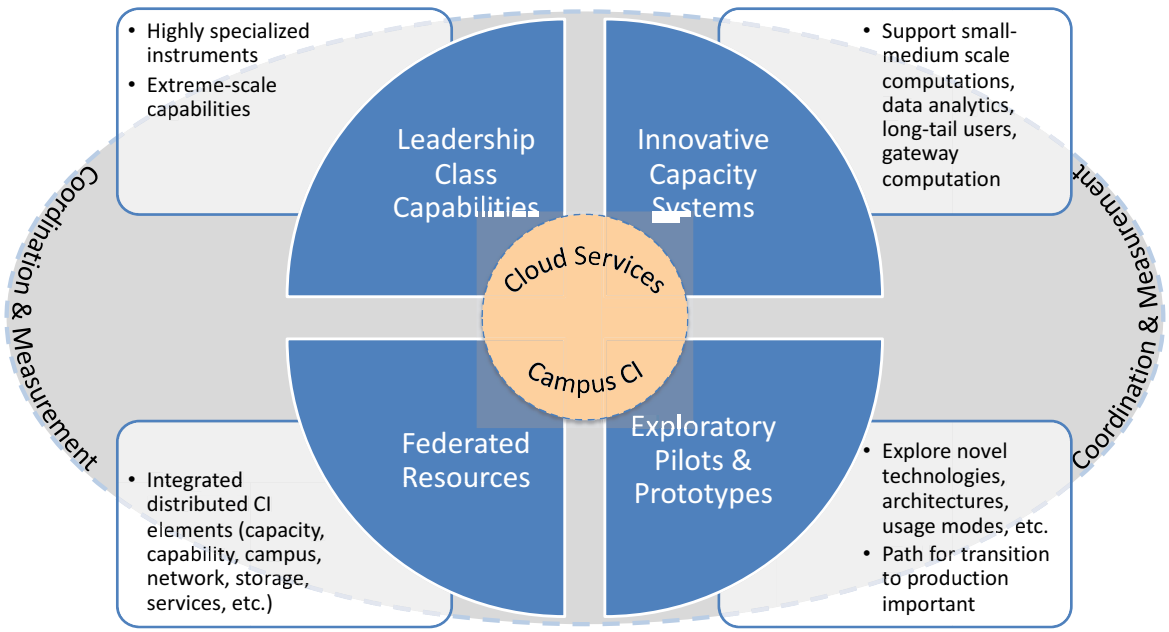


Figure 2: Elements of a balanced computational ecosystem.

natural hazards modelling and energy research to genomics and astrophysics.

Advanced Computing Systems and Services (ACSS)

NSF's Advanced Computing Systems and Services (ACSS) program supports innovative computing systems that explore novel approaches, architectures and delivery models, while at the same time serving as "production" platforms for the broad range of computation and data analytics needs of the S&E community. A key goal of these systems is to leverage federated and/or distributed resources, regional and/or campus supported resources and/or commercial cloud services.

In the last year, OAC has funded three such systems:

- **Expanse: Computing without Boundaries: Cyberinfrastructure for the Long Tail of Science**, located at the University of California-San Diego, provides increased capacity and performance for users of batch-oriented and science gateway computing; integration with the public cloud and the Open Science Grid is a key component.

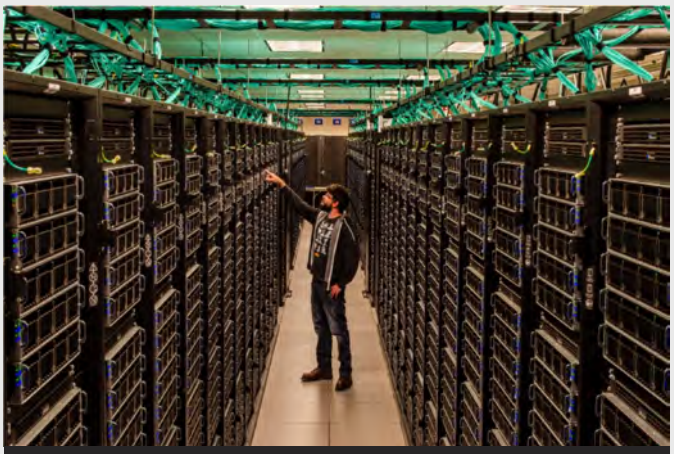
- **Bridges-2: Scalable Converged Computing, Data, and Analytics for Rapidly Evolving Science and Engineering Research**, located at Carnegie-Mellon University, provides a high-capacity, large memory system targeting high-performance data-driven analytics with machine learning/deep learning/artificial intelligence applications.

- And **Ookami**, at the State University of New York at Stony Brook, is a prototype/testbed system that seeks to explore the Fujitsu A64fx processor with ultra-high memory bandwidth to better support memory-intensive applications. It's also the first such system outside Japan that leverages this processor.

Cloud computing services

In addition to the innovative advanced computing systems and services described above, cloud computing services are playing an increasingly important role in supporting academic and research computing – and NSF has explored partnerships with commercial cloud computing providers in recent years to better integrate cloud computing services into the CI ecosystem.

For example, through NSF's CloudAccess program, **CloudBank**,[5] is supporting a collaboration among the University of California-San Diego, the University of California-Berkeley and University of Washington, and is delivering a set of managed services, including education and training, to enhance access for the computer and information science and engineering research and education community to public clouds. NSF intends to assess this pilot and potentially scale it to other fields.



The NSF-funded Frontera supercomputer at the Texas Advanced Computing Center was launched on September 03, 2019 as the fastest supercomputer at any university and the fifth most powerful system in the world.

Similarly, in the **E-CAS**[6] project, the non-profit computer networking consortium Internet2 is helping build partnerships with commercial cloud computing providers to support S&E applications that leverage new and more effective uses of cloud computing capabilities. In partnership with Amazon Web Services, Google Cloud Platform and Oracle Cloud,[7] Internet2 is leading the S&E community in investigating the viability of commercial clouds for leading-edge computational S&E supporting a range of academic disciplines.

Conclusion

Twenty-first-century S&E research and education is being actively transformed by the increasing availability and scales of computation and data. The federally funded U.S. CI ecosystem has, thus, become a key catalyst for discovery and innovation, playing a critical role in ensuring the Nation's leadership in S&E, economic competitiveness and national security. NSF plays a central role in realising this national CI ecosystem, providing advanced computing systems and services that are critical for enabling discoveries and driving innovation across all of S&E. ■

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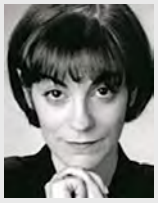
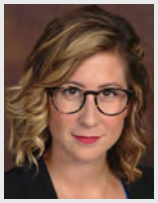
Manish Parashar
Office Director
NSF Office of Advanced Cyberinfrastructure (OAC)
National Science Foundation (NSF)
Tel: +1 703 292 2274
mparasha@nsf.gov
http://manishparashar.org
www.twitter.com/parasharmanish



Amy Friedlander
Deputy Office Director
NSF OAC
Tel: +1 703 292 2262
afriedla@nsf.gov
https://www.nsf.gov/div/index.jsp?div=OAC
www.twitter.com/NSF

Erwin Gianchandani
Acting Assistant Director
NSF Computer and Information Science and Engineering (CISE)
Tel: +1 703 292 8900
egiancha@nsf.gov
https://www.nsf.gov/cise/bios/egiancha.jsp
www.twitter.com/NSF



Allyson Kennedy
Assistant Program Director
NSF CISE
Tel: +1 703 292 8905
aykenned@nsf.gov
https://www.nsf.gov/div/index.jsp?div=CNS
www.twitter.com/DrAllysonK

Blockchain: A magic wand to omnichannel retail challenges?

Associate Professors Joline Uichanco, Stefanus Jasin and Debjit Roy offer their expertise to discuss how blockchain can be used to solve traceability, trust, and transparency challenges faced by omnichannel retailers

The word 'omnichannel' is no longer alien to those familiar with the retail industry. In the last few years, driven by fierce competition from giant e-commerce retailers, many traditionally brick-and-mortar chains such as Macy's, Walmart, and Target have been leading the way towards providing extremely convenient shopping experiences for their customers.

Today, customers of omnichannel retailers have a choice in not only the mode of purchase but also in the mode of receiving the product. They can buy through the channel of their choice such as a physical store, online, or on the phone and receive their products via shipment, store walk-ins, store pickup, or secured lockers.

Omnichannel customers have also become accustomed to an unprecedented amount of information regarding the products they buy. This includes in-store availability information, estimates of delivery times, and the visibility of product movement throughout the supply chain. Despite this, there is still a demand for increased visibility, and retailers that are able to provide this are at a competitive advantage.

For instance, many customers are wary about the origin/authenticity of the product, especially for fresh produce and high-value luxury goods, while others are socially responsible and prefer to use products that are compliant with fair trade practices at all nodes of the supply chain. In sum, to win brand confidence of an omnichannel customer, retailers need to build trust in their relationship by offering a transparent and traceable product supply chain. A quick reflection on this challenge reveals the need of easy access to either real time information or a reliable record of product movement and/or availability in the supply chain.

Can blockchain address the current misses in Omni-channel retail?

Blockchain, which operates on a digital ledger of transactions distributed among a network of computers, has found many applications in financial services. Interestingly, blockchain could be an answer to the many challenges faced by omnichannel retailers including traceability, trust, and transparency. Indeed, a recent report by fintech specialist Monica Eaton-Cardone found that about 78% of retailers will have joined the blockchain revolution by 2023. Further, the study forecasts that the blockchain retail market value could grow to $2.3 billion or at a compound annual growth rate of 96.4%, which would be the highest forecasted growth among any blockchain-related industry[1].

With blockchain technology, both retailers and customers can have real-time access to the product serial number and the process status details such as order processing status, payment status, real-time order location, and delivery status. Since blockchain works on a distributed ledger, the information blocks cannot be easily modified and the temporal pattern of

the information blocks cannot be altered, which means that all stakeholders in the supply chain has a unified view of the information.

In addition to making the purchase process more transparent, the real-time information can also provide retailers and customers with details on product flow in the supply chain from factory to store. Such information can be quite valuable, particularly during food recalls where information from the ledgers can be utilised to quickly trace back the origins of the products. Due to transparency built across all nodes in the supply chain, the B2B transaction clearing times that could be long at times is reduced significantly (Treshock, 2016). Further, transaction delays can be minimised by executing automated transactions between the retailer (franchisee) and customers, also known as smart contracts.

Initial success cases

LVMH, the world's largest luxury conglomerate, is using blockchain technology to track luxury goods and prove their authenticity[2]. Walmart is using blockchain to identify the source of its produce. When an outbreak of a food-borne disease happens, identifying the source could take several days. As noted in a Hyperledger casestudy, "(b)etter traceability could help save lives by allowing companies to act faster and protect the livelihoods of farmers by only discarding produce from the affected farms.... For pork in China, it allowed uploading certificates of authenticity to the blockchain, bringing more trust to a system where that used to be a serious issue. And for mangoes in the U.S., the time needed to trace their origin reduced from 7 days to mere 2.2 seconds[3]."

Blockchain can also promote responsible sourcing of products. Every product is assigned a barcode (digital identifier) and all transactions related to the product movement through its lifetime are recorded in a sequential fashion. For example, Moyee, a coffee roastery based out of Ethiopia[4], uses innovative blockchain technology to track the farmers compensation and makes an attempt to keep as much of the profits as possible in Ethiopia, which is one of the world's poorest country. To track sourcing from the farmers, each farmer is assigned a unique digital identity.

Further, each buyer has an access to the price at which the beans are sourced from the farmers, with prices set at 20% above the market rate. In the future, they also intend to use the blockchain platform the tip the farmers. Likewise, some of the best wool brands in Australia are attempting to ethically source wool by adopting blockchain-based farm management tools. Using a mobile device, they collect information on animal vaccinations, use of pesticides in the farm, stock movement and securely transmitted back to the consumer's smart phone[5].

While convenience pushes retail sales and customer shopping experiences, it also increases the complexity and challenges in serving the omnichannel customers. Although blockchain seems like a promising solution, it is still in its infancy. First, a shared vision among the participating entities needs to be established and the data entry need to be automated. Moreover, there are some lingering questions: Is blockchain really safe? Is it scalable for large applications? We have to wait and see if blockchain is the silver bullet to the retailers' challenges.

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Debjit Roy
Associate Professor of Operations Management
Indian Institute of Management Ahmedabad, India
Tel: +91 796 632 4823
debjit@iima.ac.in
https://faculty.iima.ac.in/~debjit/

Stefanus Jasin
Associate Professor of Technology and Operations
Stephen M. Ross School of Business, University of Michigan, Ann Arbor, U.S.
Tel: +91 734 764 2305
sjasin@umich.edu
https://sites.google.com/a/umich.edu/sjasin1/

Joline Uichanco
Associate Professor of Technology and Operations
Stephen M. Ross School of Business, University of Michigan, Ann Arbor, U.S.
Tel: +91 617 999 7258
sjasin@umich.edu
https://sites.google.com/a/umich.edu/juichanco/

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Will Europe become a world leader in supercomputing?

Here, we find out about the desire for Europe to become a world leader in the field of supercomputing, with comment from Roberto Viola, Director-General of DG CONNECT at the European Commission

In June 2019, eight sites for supercomputing centres were selected throughout the European Union (EU) to host the first-ever European supercomputers. This ambitious endeavour aims to support Europe's researchers, industry and businesses to develop new applications in many areas, such as combatting climate change or designing medicines and new materials. The location of the eight sites are Barcelona (Spain), Bologna (Italy), Sofia (Bulgaria), Ostrava (Czechia), Kajaani (Finland), Bissen (Luxembourg), Minho (Portugal) and Maribor (Slovenia). [1]

In his blog, Roberto Viola, Director-General of DG CONNECT at the European Commission, underlines the desire for Europe to become a world leader in the field of supercomputing. He says that when the computers are installed in 2020, they will be the result of a dream that the Member States and EU share, having funded the project to the tune of €900 million. In his own words, he provides his thoughts on how these new supercomputers will give Europe a massive boost.

"Combined, these new supercomputers will boost European computing by four to five times compared to current levels, a shot in the arm that will make Europe the world's leading supercomputing power by 2020. But it will do much than just lift us up the global ranking: it is also expected to generate investment of more than €10 billion in applications made possible or improved by the increase computing power, with benefits for all areas of industry, including small and medium-sized enterprises. The EU-funded Fortissimo project [2] has already given many such enterprises in a range of fields the opportunity to use supercomputers to make major discoveries and advances."

Roberto Viola also says that being the number one region in the world in this vein sends a clear message about Europe's ambitions. While this is not an end in itself, it allows Europe to achieve so much. Today, supercomputers are already behind some of the most ground-breaking applications, in almost any area you can imagine, such as advanced research on cancer, personalised medicine, environmental protection and road safety as well as cybersecurity and natural disasters' prediction. He goes on to explain the many opportunities that supercomputing will present, in his own words, as this article draws to a close.

"But the additional computing power these new sites will bring leads to a wealth of new opportunities to really push the boundaries of what we can achieve. These supercomputers will be accessible to any private or public users in the European Union. They will serve over 800 application areas including in critical domains such as artificial intelligence and big data analytics, cybersecurity and blockchain, accelerating the digital transformation of our economy and society. They will support Europe's researchers and industry in developing new applications and products in many areas, such as personalised medicine, new drugs, material design, bioengineering and manufacturing, weather forecasting, understanding climate change and many, many more." [3] ■

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DeepHealth project: Deep-learning and HPC to boost biomedical applications for health

Jon Ander Gómez and Monica Caballero, DeepHealth Technical Manager and Project Coordinator, lift the lid on an exciting project that concerns deep-learning and high performance computing to boost biomedical applications for health

Healthcare is one of the key sectors of the global economy, making any improvement in healthcare systems to have a high impact on the welfare society. European public health systems are generating large datasets of biomedical data, in particular, images that constitute a large unexploited knowledge database, since most of its value comes from the interpretations of the experts. Nowadays, this process is still performed manually in most cases. The use of technologies, such as the recent trend on bringing together high performance computing (HPC) with big data technologies, as well as the application of deep learning (DL) and artificial intelligence (AI) techniques can overcome this issue and foster innovative solutions, in a clear path to more efficient healthcare, benefitting both people and public budgets.

In this scenario, the DeepHealth project, funded from the European Union's Horizon 2020 programme, tackles real needs of the health sector with the aim to facilitate the daily work of medical personnel and related IT experts in terms of image processing and the use and training of predictive models.

The main goal of the DeepHealth project is to put HPC computing power at the service of biomedical applications and through an interdisciplinary approach, apply deep learning and computer vision techniques on large and complex biomedical datasets to support new and more efficient ways of medical diagnosis, monitoring and treatment of diseases. In line with the main goal, one of the most important challenges of the DeepHealth project is to design and implement distributed versions of the training algorithms, to efficiently exploit hybrid HPC + Big Data computing architectures by using the data parallelism programming paradigm.

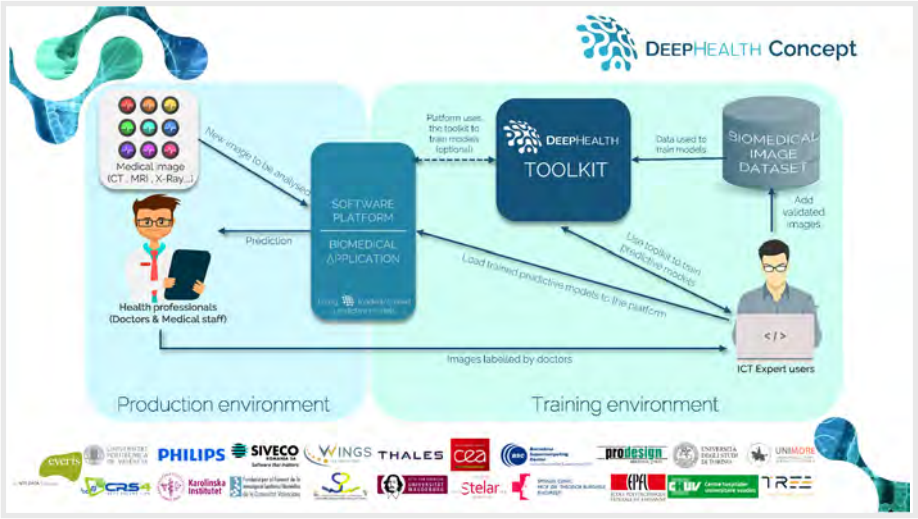
To fulfil this goal the DeepHealth Consortium, coordinated by everis and technically led by the Technical University of Valencia (UPV), involves 21 partners from nine European countries, gathering a multidisciplinary group from research and health organisations as well as large and SME industrial partners.

The DeepHealth toolkit: A key open-source asset for eHealth AI-based solutions

At the centre of the DeepHealth proposed innovations is the DeepHealth toolkit, open-source free software that will provide a unified framework to exploit heterogeneous HPC and big data architectures assembled with deep learning and computer vision capabilities to optimise the training of predictive models. The toolkit is composed of two core libraries, the European Distributed Deep Learning Library (EDDLL) and the European Computer Vision Library (ECVL) and a dedicated front-end. The front-end will provide a web-based graphical user interface for facilitating the use of the functionalities provided by the core libraries to technical people, mainly computer and data scientists, without a profound knowledge of Deep Learning and Computer Vision.

EDDLL and ECVL development are led by The Pattern Recognition and Human Language Technology (PRHLT) research centre of the UPV and the Dipartamento di Ingegneria "Enzo Ferrari" of the Università degli studi di Modena e Reggio Emilia, respectively. The Department of Computer Science from the University of Torino and the Barcelona Supercomputing Center are also strongly contributing to the adaptation of the libraries to HPC and cloud environments.

The toolkit will contribute to reduce the gap between the availability of cutting-edge technologies and its extensive use for medical imaging, through its integration in current and new biomedical platforms or applications.



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The DeepHealth concept – application scenarios

The DeepHealth concept (depicted in the Figure) focuses on scenarios where image processing is needed for diagnosis. The training environment represents where IT expert users work with datasets of images for training predictive models. The production environment is where the medical personnel ingests an image coming from a scan into a software platform or biomedical application that uses predictive models to get clues that can help them to make decisions during diagnosis. Doctors have the knowledge to label images, define objectives and provide related metadata. IT staff are in charge of processing the labelled images, organise the datasets, perform image transformations when required, train the predictive models and load them in the software platform. The DeepHealth toolkit will allow the IT staff to train models and run the training algorithms over hybrid HPC + big data architectures without a profound knowledge of deep learning, HPC or big data and increase their productivity reducing the required time to do it. This process is transparent to doctors; they just provide images to the system and get predictions such as indicators, biomarkers or the segmentation of an image for identifying tissues, bones, nerves, blood vessels, etc.

14 pilots and seven platforms to validate the DeepHealth proposed innovations

The DeepHealth innovations will be validated in 14 pilot test-beds through the use of seven different biomedical and AI software platforms provided by partners. The use cases cover three main areas: (i) Neurological diseases, (ii) Tumour detection and early cancer prediction and (iii) Digital pathology and automated image annotation. The pilots will allow evaluating the performance of the proposed solutions in terms of the time needed for pre-processing images, the time needed to train models and the time to put models in production. In some cases, it is expected to reduce these times from days or weeks to just hours.

Advances made so far and upcoming news and results

DeepHealth started on January 1st, 2019 and during the first few months, relevant advances have been made mainly on fine-tuning the 14 use-cases and the specifications and requirements of the platforms supporting them and on defining the libraries' APIs and the infrastructure requirements. Also important is the definition of ethical and data privacy requirements to deal with medical data. Please, follow us closely since in the upcoming months, it is expected the first public release of the EDDLL and ECVL.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 825111, DeepHealth Project.

Key facts:
ICT-11-2018-2019 – HPC and Big Data enabled Large-scale Test-beds and Applications

Budget: ~€14.64 million - EC funding = ~€12.77 million

Duration: 36 months (Jan 2019 - Dec 2021)

DeepHealth project

DEEPHEALTH

Jon Ander Gómez
Associate Professor
(DeepHealth Technical Manager)
Universitat Politècnica de València
Tel: +34 638 781 788
jon@upv.es
http://personales.upv.es/jon

Monica Caballero
R+D Project Manager
(DeepHealth Project Coordinator)
everis
monica.caballero.galeote@
www.twitter.com/MonknightG

The Digital Single Market: A focus on robotics and artificial intelligence

Here, we focus on robotics and artificial intelligence, two areas that come under the European Commission's wider Digital Single Market policy

The Digital Single Market strategy of the European Commission sets out to "open up digital opportunities for people and business and enhance Europe's position as a world leader in the digital economy."[1] This article will briefly examine a part of that by looking at the work of the Robotics and Artificial Intelligence (Unit A.1).

We know that the Unit sets out to push forward the development of a competitive industry in robotics and artificial intelligence (AI) throughout Europe. Certainly, this includes industrial and service robots plus the growing field of autonomous systems from drones and driverless vehicles to computing and cognitive vision.

Also, the Unit encourages the wide uptake and best use of robotics and AI in all societal and industrial fields. The Unit takes responsibility for the European Commission's participation in the contractual PPP on Robotics and for the implementation and development of the relevant strategic industrial agenda.

As well as managing RD&I projects within Horizon 2020, the UNIT keeps up-to-date with legal and ethical issues in the field of robots and autonomous systems, for example, aspects related to the impact of automation and robotics on jobs and work environment, as well as liability and safety.

Currently, Juha Heikkilä is Head of Unit at Robotics and Artificial Intelligence (Unit A.1) [2]. Juha joined the European Commission in 1998 and today works in their [3] Directorate-General for Communications Networks, Content and Technology (DG CONNECT). This is the department "responsible to develop a digital single market to generate smart, sustainable and inclusive growth in Europe." [4]

In July 2019, we find out that the European Commission launched a call to develop a vibrant European Network of AI Excellence Centres. Under the Horizon 2020 Work Programme 2018-2020, proposals for this can be submitted up to 13th November 2019. Europe has important potential to lead technological advancements in AI, with a strong research infrastructure and world-class community of scientists at their disposal. It is, therefore, crucial that the crème de la crème research teams in Europe collaborate to combat significant technological and scientific challenges.

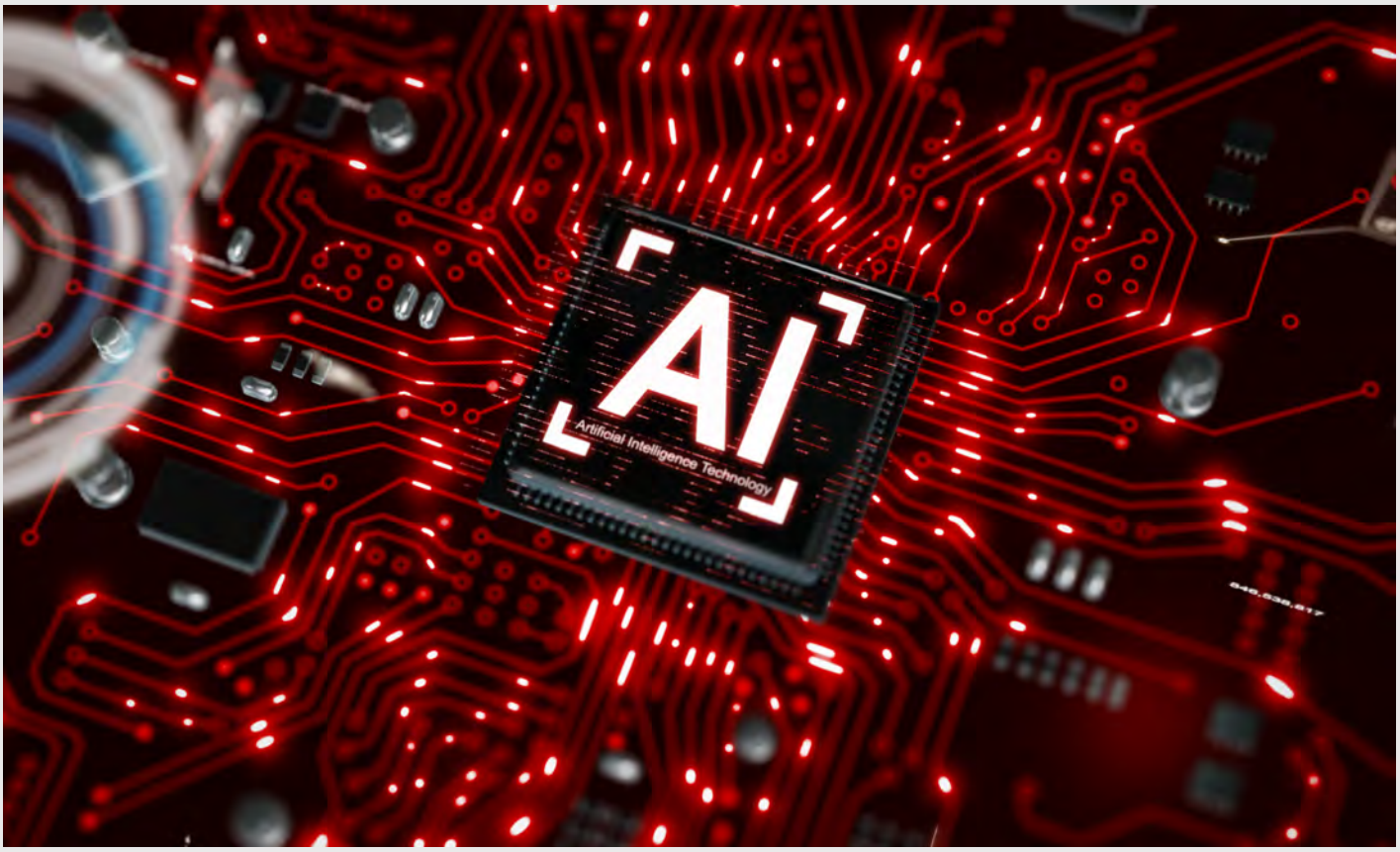
The Commission is looking ahead at a long-term effort to unify the European AI community and make the region an AI powerhouse. To achieve this, they believe that two actions are needed:

1. **Research and Innovation Action** to mobilise the best researchers into networks of excellence centres to reach a critical mass on important AI topics.

2. **Coordination and Support Action** to enable exchange between the selected projects, as well as other relevant initiatives.

These aforementioned actions should create synergies with the industrial sector and, "foster an ecosystem of R&D resources, expertise and infrastructure (in areas such as HPC, robotics equipment, IoT infrastructure)." [5]

In other news, a significant piece of robotics news from the European Commission came in late 2018 when they awarded €66,000,000 to robotics projects that will help digitise companies throughout the European Union (EU). As part of the Digitising European Industry Call of Horizon 2020, the EU's research and innovation programme, one coordination support action and four



projects have been awarded. We read more about this on the European Commission's website.

"They will all help small and medium-sized enterprises (SMEs) adopt new technologies in the robotics and artificial intelligence area. Nearly half of the money dedicated to these Digital Innovation Hubs (DIHs) projects will be dispatched to local companies by involving them in mini-projects or experiments."

The four awarded projects are:

1. **DIH^2:** A network of 26 DIHs to reach no less than 170 DIHs.

2. **DIH-HERO:** A broad pan-European network of DIHs specialising in healthcare robotics will be established.

3. **TRINITY:** The aim here is to create a network of multidisciplinary DIHs consisting of research centres, university groups companies that cover a wide array of topics.

4. **RIMA:** This sets out to establish a network of 13 DIHs on robotics to facilitate the uptake of maintenance and inspection and maintenance technologies. [6]

The topics briefly discussed are just a few examples of the excellent work of the Robotics and Artificial Intelligence (Unit A.1) within the European Commission and we look forward to future developments in this most exciting area of work. It's a really important aspect of the Digital Single Market but it's not the only part of it. ■

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European SMEs robotics applications

Dr Sotiris Makris, from the Laboratory for Manufacturing Systems & Automation, explains how innovative SMEs can implement and prove new technology, including robotics, that addresses real-life problems

Europe is home to a great number of innovative small and medium-sized enterprises (SMEs), capable of producing and delivering highly innovative solutions for the industry. However, SMEs face difficulty in overcoming the infamous "Valley-of-Death", which "traps" innovations from being transferred to the market. ESMERA provides the means for innovative SMEs to implement and prove new technology that addresses real-life problems and, thus, already have a market.

Dr Sotiris Makris

The European Commission has been supporting the industrial uptake of KETs in Europe. Key Enabling Technology – hereafter "KETs"– are the technology that enables process, goods and service innovation throughout the economy. In terms of robotics, such technology involves but are not limited to: novel robotic structures, mobile robots, manipulators, sensing technology, gripping and actuation mechanisms, navigation and control software, perception, among many other areas. Also, Europe is home to plenty of innovative SMEs, capable of producing and delivering highly innovative solutions for the industry. However, SMEs face difficulty in overcoming the infamous "Valley-of-Death", which "traps" key enabling technology (KET) products and services from being transferred into the marketplace.

Within the European Commission's Horizon 2020 Research and Innovation Programme, the project ESMERA aims to boost robotics innovation for European SMEs. ESMERA aims to embrace and support SMEs that are oriented towards the development of novel technology and require both technical and business support to accelerate the transfer of their ideas to market.

In the scope of ESMERA, key European companies defined real-life industrial challenges, that is specific problems that seek innovative solutions in manufacturing, construction, energy and agri-food. SMEs are developing robotic technology to provide solutions for these challenges. Thereby, SMEs get a chance to implement, apply and prove new technology that addresses real-life problems and, thus, already have a market. On this basis, ESMERA aims to support SMEs in the realisation, testing and promotion of robotic technology through:

- Providing industrial challenges defined by key European Union (EU) companies, stimulating SMEs to flourish by developing and promoting new technology to address real-life problems that already have a market.
- Engaging several competence centres that can provide an accessible environment for developing, evaluating, testing and demonstrating novel robotic technology.
- Offering direct financial support through a cascade funding mechanism to supplement the technical excellence offered by the competence centres, allowing prototype/product creation and promotion.
- Offering mentoring and support in developing business cases and managing the complete chain from "idea to market product" by EU champions in robotics that have successfully undergone the process.
- Involving industrial associations and networks that can directly promote the developed solutions to their members, therefore, addressing a wide range of industrial sectors and applications.

The project relies on the execution of a number of cross-border technical

mini-projects, which have been defined as so-called "experiments" involving SMEs, industrial end-users and facilitators. The single experiments are heading on the path towards developing and realising robotics solutions. Based on that, SMEs have the opportunity to produce tangible results by applying high tech in practical industrial applications. These results can be validated and communicated and appropriate plans to exploit these can be set in motion. ESMERA is offering expertise by the so-called Facilitators, who lead the mentoring of research experiments and eventually support the concrete commercialisation plans through engaging with distribution partners, investors and working with first users in the industry. In addition, the results of this first industrial application will be the basis to enable the continuous development of research experiments (after the end of the experiment). By closely monitoring the evolution of the experiments, the Facilitators actively support SMEs and aim to help them develop their strategy to maximise and exploit the potential of each experiment.

The experiments being currently supported by ESMERA are covering a broad range of application areas. Some examples of experiments being funded are listed below and follow the above-mentioned process:

- **AutoTAP** deals with Automated Taping of Wire Harnesses and addresses the current manual approach used by companies to assemble wire harnesses with insulating taping.

- **WIRECOBOTS** deals with Wire harness assembly using collaborative robots to increase efficiency and ergonomics aims to provide a robotic solution to the ESMERA-M.1 challenge: wire harness assembly task.

- **eQUALS** deals with a Quality Check System for automotive paint shop, aims to advance the quality control in manufacturing paint shops using robotics technology.

- **REFLECT** develops Human Robot Cooperation for Flexible Parts Manipulation, inspires to provide solutions to the problem of flexible parts assembly in dishwasher by implementing a dexterous gripping device in a collaborative robot.

- **MINOTAUR-R** develops Magnox spring sorting with autonomous robot in the radioactive environment and aims to increase the confidence over Nuclear Waste Sorting technology in the nuclear industry, scientific and technological community.

- **CAROB** addresses the need of farmers to replace current weeding techniques by autonomous mechanical weeding.

- **COBOLLEAGUE** focuses on Robotic Colleague for Construction Environments, proposes the development of a highly modular collaborative autonomous ground robot equipped with a gravity compensated mechanism for the autonomous transportation of heavy parts and the collaborative handling of heavy tools in construction sites.

- **EREVOS** investigates Aerial survey of railways with drones for vegetation management and aims to deliver a novel full-fledged solution for the aerial monitoring of railways using drones for vegetation management and boundary structure inspection.

- **SPAIW** focuses on Solar Powered Autonomous In-row Weeder, offering weeding solutions which aim to be lightweight, autonomous and able to clean both between and within the rows of crops, such as beets.

- **NIX** develops a Certifiable Navigation Module for Ground Robotic Inspection, intends to develop and commercialise a robot platform for remote inspection in harsh environments.

- **MANDEYE** focus is on localisation/navigation/perception/collision avoidance system for mobile robots working in harsh environments.

ESMERA is a four-year project funded by the European Commission through the Horizon 2020 research initiative. The consortium is coordinated by the Laboratory for Manufacturing Systems & Automation, University of Patras (LMS). The project consortium involves several research institutes, namely the French Alternative Energies and Atomic Energy Commission (CEA), IK4 TEKNIKER, Technical University of Munich (TUM) and three industrial companies: R U Robots, Blue Ocean Robotics (BOR) and COMAU.

ESMERA distributes to SMEs financial support of 4,4 M€ in the form of open calls. The second open call of ESMERA is currently open and SMEs are invited to submit their applications to receive funding on developing advanced robotics technology. More information is available on the project website.

LMS
Laboratory for Manufacturing Systems & Automation

Dr Sotiris Makris
Laboratory for Manufacturing Systems & Automation (LMS)
Department of Mechanical Engineering and Aeronautics
University of Patras
Patras 26504, GREECE
Tel: +30 2610 910 160
www.lms.mech.upatras.gr

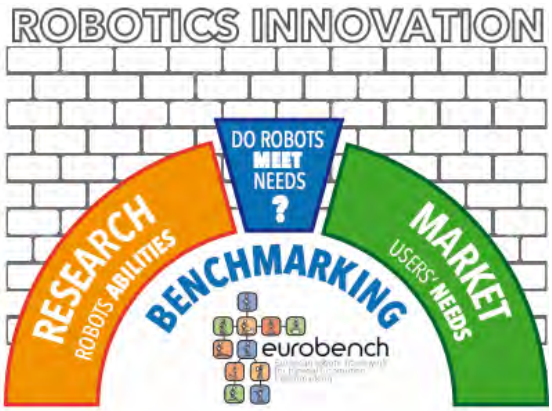
Benchmarking: The keystone of robotics innovation

The H2020 Project EUROBENCH and GET2EXCEL are creating the first benchmarking and standardisation framework for robotics innovation worldwide, much more of which we find out about here

Robotics has entered a new exciting era. For the first time, robots are facing the challenge to work in close interaction with humans in everyday life activities. This new field, called Interactive Robotics, is receiving particular attention in the research community, with an increasing number of projects and initiatives. Most of the current research & development efforts are focused on improving robots' abilities, e.g. stability, robustness, and safety in out-of-the-lab environments. To allow these new machines to be perceived as a real value by the society and survive in this rapidly evolving technological landscape, one question is yet to be answered: "To what extent can robots meet real users' needs?". Without a concrete and quantitative answer to this question, the entire robotics innovation chain is put into danger. Benchmarking can, therefore, be the key solution.

What is benchmarking?

Benchmarking is the process of comparing different systems by using a common standard or point of reference. Benchmarking aims to generate quantitative and clear performance scores that help costumers quickly identify which products better fit their needs. Benchmarks can be eventually translated into international standards, to drive policymakers in ensuring a smooth and safe introduction of novel technologies into existing market domains. Benchmarking can be also of great help to scientists and technical developers, establishing clear technical targets to demonstrate a certain readiness level of the technology. Benchmarks are well established in many markets and scientific domains, e.g. mobile phone technology, electrical appliances, automobile and internet connections. Unfortunately, when it comes to robotics, these aspects have been largely overlooked. With the advent of Interactive Robots, which are going out of the classic industrial environment entering the consumer market at an exponential pace, the need for benchmarks and standards is now evident. Nevertheless, a generalised, well-accepted and comprehensive benchmarking methodology does not exist yet. The EUROBENCH and GET2EXCEL projects aim to fill this gap.

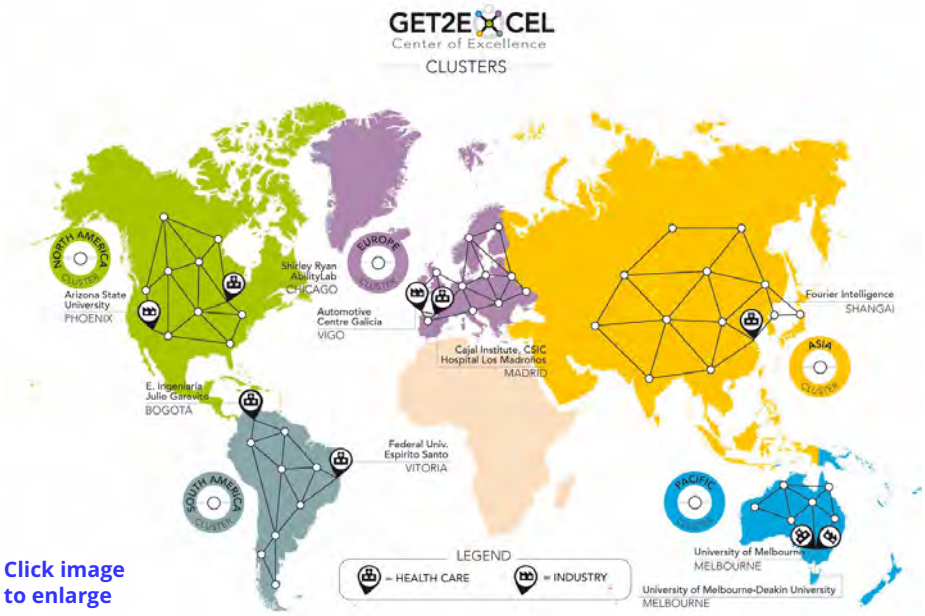


The EUROBENCH project

The H2020 Project EUROBENCH is creating the first framework for the benchmarking of Interactive Robots worldwide. The project is currently focusing on bipedal robotics technologies, i.e. wearable robots (exoskeletons and prostheses) and humanoid robots, aiming to expand towards a wide range of robotic technologies. The EUROBENCH Consortium, with the help of 17 Consortia funded by the first EUROBENCH Open Call (FSTP-1, now closed), is currently developing the three main pillars of the benchmarking framework:

Two testing facilities. EUROBENCH is creating two testing facilities (one for wearable robots and one for humanoids) equipped with state-of-the-art testbeds, which replicate the main conditions encountered by humans in daily life locomotion, such as slopes, stairs, obstacles, unstable terrains, as well as external disturbances, e.g. pushes. These testbeds will allow testing the performance of the robotic machines in typical human-like environments.

One Benchmarking Software. The project will release a Benchmarking Software suite to allow any researchers, developers or users worldwide to replicate the testing experiments in their own laboratory settings and automatically calculate relevant indicators on robot performance.



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One unified database. EUROBENCH will gather and organise all the data recorded by the EUROBENCH users into a unified database. This data, combined with AI techniques, will produce efficient comparison algorithms and reliable predictors to allow users to identify the best match between their needs and available technologies.

With the community, for the community: the GET2EXCEL Center of Excellence

The ultimate goal of EUROBENCH is creating a sustainable "benchmarking infrastructure" and to make it available to the general public, as well as the research and industrial community worldwide. For this reason, we are now creating a portfolio of services for future users of the framework. To involve scientific and industrial experts in validating and improving these services, we will allow third parties to become beta testers of the EUROBENCH framework, at zero costs. Through the Second competitive Open Call (FSTP-2, open from June-August 2020), we will offer financial and technical support to a selected number of participants to exploit the EUROBENCH tools (facilities, software and datasets) to test their robotic technologies, either commercial or prototypal. All the testing experiments will be developed in total respect of confidentiality and industrial secret requirements of participants.

This is not all. EUROBENCH is at the core of a new initiative, the GET2EXCEL Center of Excellence (CoE), a global network including all relevant stakeholders and organised in five cluster areas: North America Cluster, Europe Cluster, Asia Cluster, Pacific Cluster and South and Central America Cluster. Each of the cluster areas is coordinated around physical sectoral Hubs, where testing, benchmarking and R&D infrastructure are available. Therefore, the EUROBENCH reach has been broadened through this CoE for global leadership, including collaborations with several international standard organisations (e.g. ISO, ASTM) to boost the process of converting the current and future benchmarking procedures and methodologies into accepted standards for the evaluation of the different facets of robotic performance. This will facilitate the efficient introduction of these new technologies into the different domains, e.g. healthcare, manufacturing, logistic, consumer, each of them characterised by the needs, requirements and regulations of diverse users and applications.

In conclusion, EUROBENCH and GET2EXCEL are working hard to prepare the Society to improve and accelerate the introduction of Interactive Robotics in people's lives, by means of new tools that will help: 1) Developers to identify the key technological factors to improve current robot abilities; 2) End-users to identify whether a specific robot can meet a real user's need' 3) Researchers to "stand on giants' shoulders", replicating scientific experiments across laboratories and robotic platforms, achieving true comparison of results and 4) stakeholders, to be fully involved in (and able to influence) the standardisation process worldwide.

Both initiatives are now welcoming new participants. Be part of it!

NRG NEURAL REHABILITATION GROUP | SPANISH RESEARCH COUNCIL

Diego Torricelli, PhD
Coordinator of the EUROBENCH Project
Spanish National Research Council (CSIC), Madrid, Spain
diego.torricelli@csic.es
www.neuralrehabilitation.org/en
http://eurobench2020.eu/
www.twitter.com/diegotorricelli
www.twitter.com/Eurobench_RIA

Jose L. Pons, PhD
Chair of the Legs & Walking Ability Lab, Coordinator of the GET2EXCEL CoE
Shirley Ryan AbilityLab & Northwestern University, Chicago, U.S.
jpons@sralab.org
www.sralab.org
www.twitter.com/jlponsrovira

Connected growth: Catching up with the new digital world

In June 2019, the Association of Directors of Environment, Economy, Planning and Transport published its key policy position on how to deliver digital connectivity across the country post Brexit. The new Chair of ADEPT's Digital Connectivity Working Group, Nicola McCoy-Brown, talks about delivering digital connectivity across the country

Connectivity has become fundamental for everyone and good internet access is now widely viewed as the 'fourth utility'. Digital technology underpins almost every aspect of modern living across work, travel, leisure and health and digital infrastructure is now as important to our economy and society as traditional infrastructure and utility services.

However, most of the UK's internet has been powered by copper wiring. It is no longer fit for purpose and hopelessly out of date for the requirements of the Third Industrial Revolution.

The deployment of telecoms networks and infrastructure is, therefore, essential to ensure that everything and everyone can connect – but access to the digital world does not happen uniformly. Over the last five years, close to £1.7 billion has been spent on reaching 95% of homes and businesses in the UK with superfast speeds of 24 Megabits per second (24Mbps). Yet the gap remains between the communities that have access to this technology and those that do not.

More work is required to close this digital divide. The step towards world-class connectivity for all, coupled with making it easier and cheaper to deploy mobile infrastructure, requires the fostering of next-generation Gigabit (1000Mbps+) capable full-fibre infrastructure.

ADEPT's Digital Connectivity Working Group was established with the Local Government Association in 2018 to explore digital connectivity, focusing on: the number of new-build homes being built that are not fibre-enabled; the disparity in mobile coverage; and how to drive the deployment of a world-class digital infrastructure.

As a result of this group, ADEPT published its policy position on Digital Connectivity in June 2019. The policy sets out the importance of having a full-fibre network, with 5G linked to this and contains seven asks of government, Ofcom and the industry. These include issues around coverage, quality, competition, new builds, delivery impact, local industrial strategies and inclusive connectivity.

Ultimately, ADEPT wants to see digital connectivity enshrined in local industrial strategies and local development plans so that it is prioritised in the same way as other utilities.

One critical area outlined in the policy position is around new builds and infrastructure capability. Whilst Fibre to the Premises (FTTP) coverage is improving, a natural time lag between various policy changes and their implementation exists.

Most of the major homebuilders have entered into partnerships with network operators to better facilitate the roll-out of full-fibre and slower hybrid fibre-based technologies. A 2016 EU directive, which was adopted into UK law, means all newly constructed buildings are equipped with infrastructure capable of delivering high-speed broadband. However, it is still left up to the developers and Internet Service Providers to decide whether to deploy an actual working service. Although more new homes have superfast and/or full-fibre availability, we are still a long way from seeing united support for superfast in new build premises.

Recently, the government identified that approximately 10% of UK premises, largely in rural and remote areas,

Nicola McCoy-Brown, Chair of ADEPT's Digital Connectivity Working Group

would be unlikely to receive gigabit-capable connections commercially by 2033. To address this, the Rural Gigabit Connectivity programme was launched, which uses an 'Outside In' approach to ensure rural areas are not disadvantaged. This approach targets the rural and remote areas first and should see the identified 10% of premises reached at the same time as the commercial roll-out happens across the UK.

The decision to tackle some of the hardest to reach places first is a significant shift in government policy and will be instrumental in delivering the ambitious plans for a nationwide full-fibre broadband network by 2033. In addition, the government has pledged full-fibre broadband coverage by 2025, which equates to moving the goalposts forward by eight years. Neither deadline, however, is backed by actual plans.

ADEPT's policy position also calls on the sector to work together to deliver access to fast and reliable broadband and mobile coverage across the country, to unlock the economic benefits of digital technology. We know that collaboration is key to delivering digital connectivity – we need to ensure that dialogue is open, transparent, that information is robust and reliable and that we share it effectively.

ADEPT recognises there are unique challenges for local authorities too. When councils became involved in the technology industry, many local authorities were not equipped to respond effectively, with skills gaps in some areas. Although we now have a talented bank of people, moving into the mobile networking industry may present similar challenges.

ADEPT needs to be ambitious in its remit around digital connectivity. We have a unique opportunity, given our links to both government and private sector corporate partners. Local authorities have an integral role as influencers, purchasers and decision-makers where inclusivity and diversity need to be embedded in all the services we design and commission. When it comes to rolling-out full-fibre, this means removing barriers and creating opportunity for all segments of the population. We need to challenge the definition of 'value for money' and instead target some of our remotest communities and those excluded due to the cost of delivery.

The UK is playing a serious game of catch up. Less than 10% of the nation currently has a full-fibre connection, which is miniscule when compared to Spain which has more than 33.3 million access points, covering more than 75% of the population. It is for this reason that ADEPT also wants to see more incentives, as well as requirements for mobile network operators (MNOs) to provide better, affordable services for rural areas. There must be more certainty and powers to ensure that coverage and compliance are assured by Ofcom. Only through these measures will we achieve world-class connectivity for all. ■

More information about ADEPT can be found on its website: (www.adeptnet.org.uk)

Digital Connectivity Policy Position – (www.adeptnet.org.uk/documents/digital-connectivity-policy-position)

Nicola McCoy-Brown
Chair of ADEPT's Digital Connectivity Working Group
Association of Directors of Environment, Economy,
Planning & Transport (ADEPT)
Tel: +44 (0)1579 352 600
secretariat@adeptnet.org.uk
www.adeptnet.org.uk/welcome-adept
www.twitter.com/ADEPTLA

Is the future paperless for local government offices?

Is the future paperless for local government offices? No – and we shouldn't force them to be, says Robyn Boyd on behalf of PFU (EMEA) Limited – a Fujitsu company

In 1975, the director of Xerox's Palo Alto Research Center Incorporated (PARC) George E. Pake shared his prediction for the future office. He certainly predicted some of it accurately, saying that: "everyone will have a TV-display terminal with a keyboard at their desk" with the ability to: call up documents from my files on the screen, or by pressing a button... I can get my mail or any messages." George also said: "I don't know how much hard copy [printed paper] I'll want in this world." And for that, he is almost right. For those who are unfamiliar with the 'paperless office' idea, or 'paper-free' office, it is the concept of a working environment in which the use of paper is eliminated. This is done via digitisation; converting documents and other documents into digital form and recycling the tangible items.

Let's move towards becoming 'paper-light' instead of 'paperless'

Currently, 65% of people of all ages say they print "very frequently", defined as every day or three to four times a week (IDC Office Printing Survey, 2017). With figures this high, it makes the concept of an entirely 'paperless' office a broken dream.

Now is the time where the conversation has the opportunity to change. Rather than being paper-free, offices can aim to achieve to be 'paper-light' and do paperwork accordingly for each establishment, with digitisation processes to support.

Paper and local government

Every part of the public sector requires paper to be processed effectively and in line with compliance regulations, to allow the secure delivery of services provided. The regulations, client demands and data security issues can be confronted to make the capturing and processing of documents into information systems crucial for local government establishments; especially for those staff members working directly with the public in a customer-facing role. Paper is often piled up on desks, in drawers, or tucked away in filing cabinets. With paper spread across so many different places, it is difficult to both track and record the information it holds.

The public sector is under pressure to capture and retrieve data from documents and make decisions rapidly based on insight from all data available. To better serve the public, the new reality is to make paperwork effectively, not merely becoming paperless.

Being able to scan documents massively reduces the time spent doing manual input and also immediately delivers the captured data for decision making.

Digital transformation

There is pressure on the public sector to undergo a 'digital transformation' and now, with the advent of the General Data Protection Regulation (GDPR), there are further pressures on staff to ensure public information is stored securely.

> "It is unlikely that a genuine "paperless" office is achievable, for the foreseeable future, but with affordable automation solutions and the changing nature of our relationship with paper, the tools are certainly in place to make progress in becoming paper-light and making paperwork better for local government offices."

Often this feels like another mountain to climb, but for local government establishments, the opportunity to automate processes using digital technology is available offering significant benefits. For many sectors, document capture is the first step towards digital transformation, allowing data to be freed from its paper prison, to support better planning and decisions.

Physical storage costs can be reduced by scanning archived documents and storing them in a secure cloud-based system. The digitised documents can be archived in a safe, easily accessible way, reducing the costs of both needing to store the originals on-site and physically retrieve them.

A growing demand is a rise in working from home or flexible working. It enables collaboration, even when not face-to-face. An example where this is already happening is within the healthcare industry, where patient records can be simultaneously accessed amongst teams of medical professionals.

When hardware and software collide, to help make paper work

At PFU, our product portfolio of hardware is split into two: ScanSnap and Fujitsu Imaging Scanners. ScanSnap is designed for personal productivity and when it comes to software for the machines, we offer ScanSnap Cloud with our ScanSnap products. It can classify and sort your paper and sends it to the right cloud space. Documents, receipts, business cards and photos are delivered directly to the cloud service you use. ScanSnap Cloud is not a cloud storage system in itself, but instead, it complements those services. It's an intuitive cloud-based image processor and enhancement tool paired with the intelligence to classify scanned input into four essential types of content; as either document, photo, business card or receipt. This means departments can share documents easily and information shared is not constrained by the brick walls of an office building.

For our Fujitsu Imaging Scanners, we have the PaperStream software. By combining market-leading Fujitsu fi Series document scanners with our PaperStream software, you can transform time-consuming and error-prone manual paper-handling into super-fast, error-free, high-quality document digitisation that significantly increases your efficiency and productivity.

Organisations have been using scanners for many years and multiple industries rely heavily on scanners to turn paperwork into digital formats that can be saved and shared. However, until recently, they have built on a very manual approach in terms of how they classify and manage captured data. That's where our Fujitsu fi-7300NX model and our partner, Lemmana, Machine Learning-supported content services software have changed the way businesses can work. Making it possible at the touch of a button, to scan, automatically extract, classify and use data to deliver a more agile way of working. Plus, because it can learn, this new generation scanner can recognise previous data, for example, patient or customer details and then file similar information away in the same place, saving time and eradicating any human error.

It is unlikely that a genuine "paperless" office is achievable, for the foreseeable future, but with affordable automation solutions and the changing nature of our relationship with paper, the tools are certainly in place to make progress in becoming paper-light and making paperwork better for local government offices.

Robyn is a PR and Social Media Executive for PFU (EMEA) Limited, a Fujitsu company and focuses on the current and future place of paper in local government establishments and how technology can support it.

PFU
a Fujitsu company

Miss Robyn Boyd
PR & Social Media Executive
PFU (EMEA) Limited – a Fujitsu company
Tel: +44 (0)20 8606 4661
Robyn.Boyd@uk.fujitsu.com
www.scansnapit.com
www.twitter.com/ScanSnapUK

The rise of cyber-stalking

Ernest Aduwa, Solicitor at specialist criminal defence and civil litigation firm Stokoe Partnership Solicitors, charts the rise of cyber-stalking

Social media has given rise to new opportunities for cyber-stalking. Cyber-stalking is a form of cyber-crime that takes place online when a person uses technology to harass or threaten another person or business. Cyber-stalking includes trolling, which is essentially a group or an individual harassing others online. Sometimes this can be for entertainment and sometimes this can be very intimidating.

The internet and social media make this possible. They create a breeding ground for would-be stalkers and allow individuals, who could be anywhere in the world, to mask their identity by using fake profiles in order to attack their victim at any time, with little possibility of being caught or identified.

For the attacker, there might be a sense of righteousness in pursuing a course of conduct that would amount to harassment. For the victim, it can become anything from a small nuisance to a huge financial burden. For example, an attacker may go beyond sending multiple critical messages about the victim, to sending messages that are defamatory and/or threatening of violence. Attackers may also exploit the vulnerabilities of their victim to blackmail them – for instance, if the attacker were to gain access to their victim's online accounts or profiles.

We are now in a globally connected world, where much of our social life is public and on social media. This means that for an attacker, it is easy to spy on a person's activities via social networking. It is, perhaps,

impossible for anyone to truly inoculate themselves from becoming a victim of cyber-stalking unless one is to completely 'log off' from the internet entirely. There are ways to minimise the risk and affect cyber-stalking has, which include:

- Using a Virtual Private Network (VPN) to protect your personal data and online browsing habits.
- Make all social media accounts private and only accept invitations to connect from people known.
- Use long passwords, with symbols, letters and numbers. Regularly change your passwords and never use the same one for different accounts.

Never share your location on social media. Be aware that when you upload pictures you can inadvertently share your location.

> "We are now in a globally connected world, where much of our social life is public and on social media. This means that for an attacker, it is easy to spy on a person's activities via social networking. It is, perhaps, impossible for anyone to truly inoculate themselves from being a victim of cyber-stalking unless one is to completely ' log off' from the internet entirely."

If you are a victim of cyber-stalking, you should try to gather as much evidence as possible, documenting all contact. It is also important to report any cyber-stalking immediately after becoming aware of the situation so that, where possible, techniques can be used to trace the suspects before data is lost.

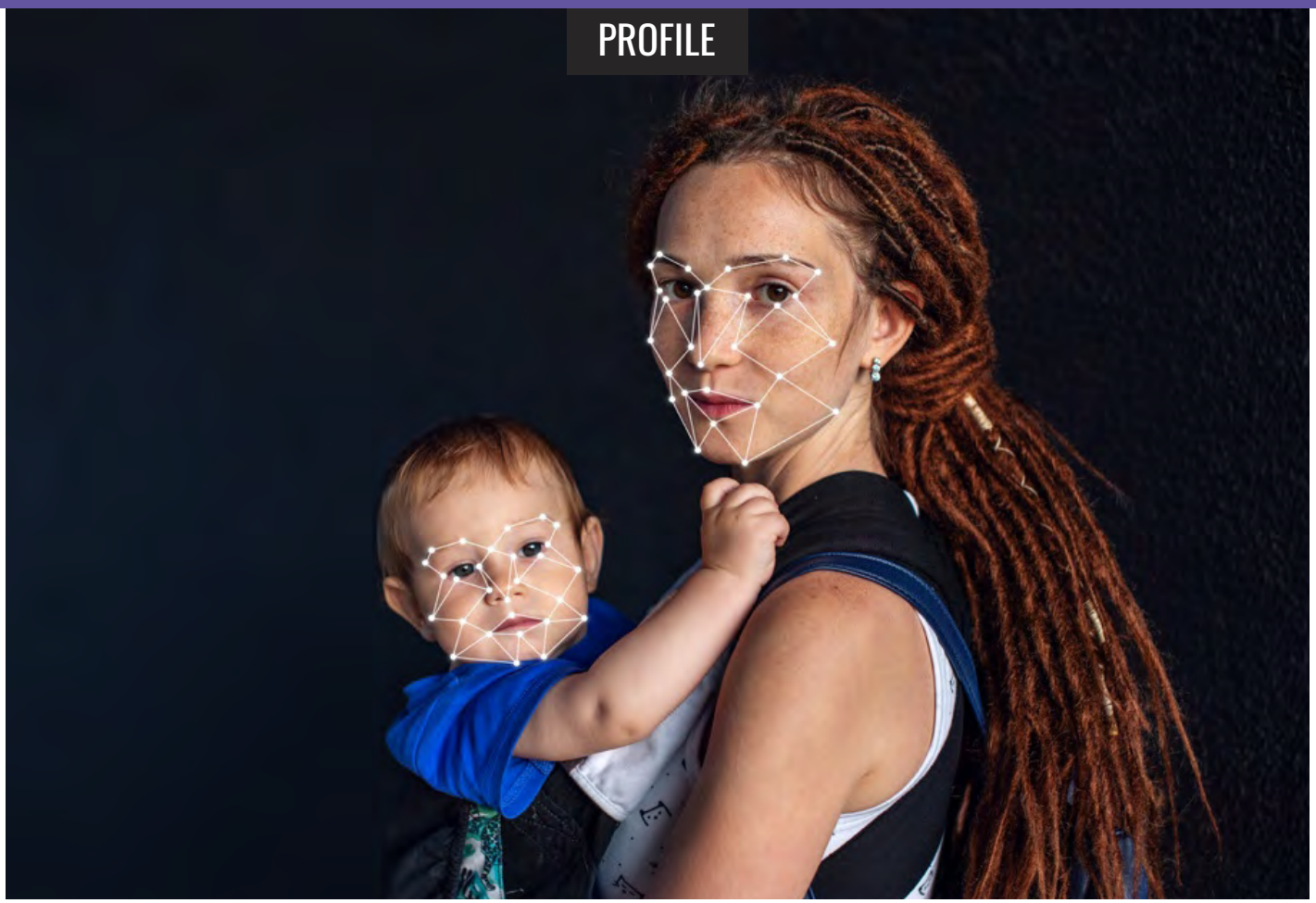
In the United Kingdom, the Protection from Harassment Act 1997 contains an offence of stalking covering cyber-stalking, which was introduced into the act through the Protection of Freedoms Act 2012. Depending on the act committed, a person may also be committing offences, contrary to other UK laws such as the Offences Against

Ernest Aduwa

the Person Act 1861, such as threats to kill; the Sexual Offences Act 2003, such as sending indecent images; and the Malicious Communications Act 1988, such as sending grossly offensive communications.

In the UK, offences under these Acts are treated very seriously and could result in immediate prison sentences imposed upon a person convicted of such an offence. ■

Ernest Aduwa
Solicitor
Stokoe Partnership Solicitors
enquiries@stokoepartnership.com
www.stokoepartnership.com
www.twitter.com/StokoePartners



Cybercrime, illegal content online: We don't have to turn a blind eye

Marsali Hancock from EP3 Foundation underlines that we don't have to turn a blind eye concerning cybercrime, illegal content and harmful activities online

As we connect new generations of children and communities online, our unique opportunity is to be the generation that implements new, additional, privacy-protecting designs and protocols. Cybercrime, illegal content and harmful activities don't have to threaten our national security or the physical safety of our children.

Information and communications technologies (ICTs) enable world citizens to instantly access digital systems that have the potential to create better standards of living, improve health, save lives, educate, entertain and inspire. For the three billion of us who have access to the Internet, very few of us could imagine living productive lives without Internet connectivity. And many of us live, eat and breathe access to online systems that define careers, family life and for many, our very identity.

The world, with its circumference of over forty thousand kilometres, has shrunk to the size of our hand-held devices and we are able to go anywhere, see anyone and do anything at the touch of a screen. And therein lies not just the bright future of our children but also the concern for their safety and well-being. The vast potential the Internet holds for billions of people across the world is balanced by the responsibility to use this tool in the most effective and responsible manner possible, especially when safeguarding the world's children.

> "As we are at the midpoint of connecting the entire world, it's time to consider how we are doing at reducing cybercrime and child exploitation."

Against that backdrop, responsible digital skills and enhanced cyber wellness are increasingly important in

a civil society. Information superhighways bring more than just convenience. Studies suggest that a 10% increase in internet penetration is correlated with a 1.35% increase in GDP for developing countries GDP. However, the superhighways also bring cybercrime, exploitation and radicalisation.

The list of risks could be considered overwhelming. Online predators and cyber-stalkers pursue and prey on children. Impressionable youth are the victims of bullying, cyber-attacks and fraud. Terrorist cells have discovered that the internet can promote their activities and methodologies and also act as an effective recruitment tool among the younger generation. Sexual violence and other harmful products and problematic behaviours are exacerbated by their almost effortless accessibility. Additionally, intellectual property theft and identity theft have repercussions that could harm a person for decades.

As we are at the midpoint of connecting the entire world, it's time to consider how we are doing at reducing cybercrime and child exploitation.

New tools and privacy-protecting data practices are, therefore, required.

When first connected, children need protection. Digital skills, alone, cannot substantially reduce the risks from children's access to harmful content or being targeted and groomed for sexual exploitation and radicalisation. New data paradigms are required to shield them and protect them from their own youthful experiences and indiscretions, including self-generated content. To thrive, they must understand this new environment, but we also need to implement ways to protect them. We cannot completely control what they consume online, but we can protect who sees their actions online.

Every action they take is tracked online, whether it's because of cookies, web beacons, or e-tags. Offline, teens have their movements tracked by new sensors in devices, loyalty programmes or discount codes. Each action carries a code that enables companies to track and sell that data and since it is connected to the child, their actions can be revealed to malicious entities, such as hackers.

It is vital to establish new systems to protect our children and ensure the internet serves as a driver for innovation, scientific research, economic growth and social development. How we manage the internet and the deployment of the Internet of things (IoT), artificial intelligence (AI), blockchain and other distributed ledger technologies (DLT) will determine whether our society is able to move toward an internet that benefits all people around the world.

What better way to do this than to hide the identity of the child and only send out relevant data to companies rather than every action the child has taken?

Rather than tracking everything the child does online, EP3 Trusted Data Networks break down the data to the attribute level, keeping the information, but hiding the identity of the child. This still gives organisations access to important data that could track societal trends but never reveals the child's identity. The only way for the child's identity to be revealed is for a trusted identity to directly ask the child to reveal it. Once they have this layer of protection, guardians and parents can then support and protect their child from risks they can manage, such as cyberbullying.

There are many risks associated with going online, but we can take steps to protect our children from malicious entities. It may be a challenge, but we can do something to protect our children online. After all, "the power of the Internet hinges on users' willingness to trust it" and in the end, use it for the benefit of all. (1)

(1) See Supra. Internet Society, 2017 Internet Society Global Internet Report: Paths to Our Digital Future, (2017) p. 72.

EP3 FOUNDATION

Marsali Hancock
EP3 Foundation
Tel: +1 4088 007 202
marsalih@gmail.com

ENISA: Working to improve cybersecurity in Europe

Here, we find out some of the ways how the European Union Agency for Cybersecurity works to improve cybersecurity in Europe

Since 2004, the European Union Agency for Cybersecurity (ENISA) has worked to make Europe cyber secure. Going into a bit more detail, we know that ENISA actively contributes to European cybersecurity policy, in that it supports the Member States and European Union (EU) stakeholders to respond to large-scale cyber incidents across borders. This work is a vital part of the correct functioning of the Digital Single Market.

ENISA works closely with the Member States, as well as the private sector to deliver solutions, advice and aim to improve their capabilities. Amongst other things, this support includes:

- Pan-European cybersecurity exercises;
- The evaluation and development and of national cybersecurity strategies and;
- Studies on smart infrastructures and the Internet of Things (IoT), privacy-enhancing technologies and privacy on emerging technologies, addressing data protection issues, eIDs and trust services and identifying the cyber threat landscape. [1]

In terms of the organisation's leadership, we know that Prof Dr Udo Helmbrecht became ENISA's Executive Director back in October 2009. He was appointed to the role after making a statement to the European Parliament and replying to MEPs' questions during April 2009. In September 2014, ENISA's Management Board extended the Director's term of office for five years and, of course, that recently came to an end. During his 10 years at ENISA, Prof Helmbrecht was assisted by an Advisory Group and ad hoc Working Groups on technical and scientific matters. [2] In his CV, we find out how his leadership clearly benefitted the excellent work of ENISA.

"Under Helmbrecht's leadership, ENISA has consolidated its role as a centre of network and information security expertise, and continued its work to facilitate cooperation in network and information security across Europe." (3)

Of course, the vital work continues with Mr Juhan Lepassaar, who was appointed Executive Director of the Agency. On 16th July 2019, the Management Board of ENISA selected him as Prof Helmbrecht's replacement.(4) In more recent news, we learn that ENISA and the European Security and Defence College (ESDC) hosted and organised training dedicated to information security risk management (ISRM).

27 seasoned professionals from nine Members States and four EU institutions had their cybersecurity knowledge reinforced over two days. Such an event is a fantastic opportunity to exchange good practices and experiences and, of course, to hone their cybersecurity and risk management skills. Those taking part can, therefore, transfer what they have learnt back to their respective organisations which can only be of enormous benefit. (5)

"Under Helmbrecht's leadership, ENISA has consolidated its role as a centre of network and information security expertise, and continued its work to facilitate cooperation in network and information security across Europe."

A significant piece of ENISA news from early September 2019, when a report was published to direct incident response teams who must facilitate information exchange among teams and improve reaction time to security incidents. The press release gives us a valuable insight into the vital work of incident response teams in sharing threat and incident information.

"As of June 2019 there are more than 414 incident response teams in Europe. These teams work together to respond to cyber-attacks and need to use secure and reliable communication channels to share threat and incident information while protecting European citizens and businesses. These incident response teams are often organised in communities such as CSIRTs Network, TF-CSIRT, FIRST and other regional, sub regional or sectorial communities and they continuously communicate and exchange information. Typical information exchanged among teams include threat intelligence, indicators of compromise (IoCs), malware samples and details about relevant incidents."

In closing, I would like to say that the above examples illustrate really well ENISA's work since 2005 in supporting Member States and Computer Security Incident Response Teams (CSIRT) communities in Europe to build and advance their incident response capabilities by means such as onsite and online training, handbooks and dedicated projects. A key part of ENISA's work concerns setting up, developing or running or capabilities of CSIRT's. Let's finish with the words of the ENISA: "The goal is to define minimum common baseline practices across the EU to improve operational cooperation, preparedness and information exchange for the next generation of cyber-attacks." (6) ■

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A better digital future: Meeting the ethical challenges of connected technologies

Irina Shklovski, Associate Professor at the IT University of Copenhagen, explains meeting the ethical challenges of connected technologies in today's world and how the VIRT-EU project helps to address this concern and move us towards a better digital future

Connected devices are entering our homes, our lives and ever more intimate spaces, collecting data about incredibly private moments and we are asked to trust these opaque systems with the data they collect. Their usefulness is sometimes questionable and sometimes undeniable, but the crucial question is: Who is responsible for the behaviour of these devices? Google's infamous "Don't be evil" motto seems to give a simple answer to this question – if technology developers are not working with explicitly evil intent then everything should be alright. Yet today's realities caution against such unbridled optimism. The VIRT-EU project addresses this problem by creating tools that can help technology developers to bring ethics into their conversations and decision-making.

Technology developers face systemic challenges of balancing personal data management with mounting privacy concerns in an increasingly complex regulatory environment especially in the area of the Internet of Things (IoT). Connected technologies render problems of data sharing and responsibility more acute as features and risks are 'designed into' devices and services that are entering our lives and homes in ever more intimate ways. There is no playbook, no rules of conduct and IoT developers are essentially charged with making moral choices about how the technologies, some of which have become indispensable to our lives, ought to behave. Many developers are concerned about the tools and services they are building but have little practice or training for dealing with ethical questions they encounter in the process. Worse, where ethical issues become visible, it can be difficult to explain the problematic nature of particular design requirements or client requests and to push against demands for more invasive features and capabilities. The VIRT-EU project steps into this gap arguing that if we want a better digital future, we best consider how to help the people that are building it for us.

The VIRT-EU project

VIRT-EU is a three-year project (running from January 2016-December 2019) funded by the European Union's Horizon 2020 and led by Professor Irina Shklovski (Coordinator) from the IT University of Copenhagen. The project consortium includes three other higher education institutions: London School of Economics and Political Science led by Dr Alison Powell, Uppsala University led by Dr Matteo Magnani and Politechnico di Torino led by Professor Alessandro Mantelero; one SME: Copenhagen Institute of Interaction Design led by Annelie Berner and one non-profit organisation: Open Rights Group led by Javier Ruiz.

VIRT-EU sets the groundwork for a more ethical European ICT innovation environment by employing state-of-the-art multidisciplinary empirical research in combination with legal scholarship and design research. We aim to develop a VIRT-EU toolbox rooted in a practical approach to ethics through a blending of key ethical approaches, design methods and broad stakeholder engagement to identify how to connect such tools to everyday practices of developers and innovators as they are building new technologies.

What do we mean by ethics?

In general terms, ethics concern the frameworks and principles that define and shape our ability to lead a life in accordance with our values and to act according to our rights, obligations and responsibilities. Ethical frameworks have a similar role in technology, guiding decision-making in the process of design and development. It is not always about what decision has been made but how it has come to be made. Ethical reasoning requires reflection, discussion, deliberation. It might slow the process down – we might not always be able to "move fast

and break things" but perhaps that is exactly what we need – to slow down and think things through. VIRT-EU conceptualises ethics as values in action taken in contexts – within power relationships and constraints. For us, ethics is a process that must include the acknowledgement of responsibilities for power. After all, technology design is a position of power to shape the way we think, the way we live and, ultimately, our future.

We studied how developers, small enterprises and individual designers in the IoT field discuss and share knowledge, how ideas and ethical values develop and travel. From this, we noted that there was a proliferation of statements, calls and manifestos for better, more ethical and more responsible technologies, which speaks to a broadly shared concern about how technological decisions might play out in the long run. Despite sincerity and passion, these documents demonstrated a stark failure of imagination in proposing significant alternatives or solutions (Fritsch, Shklovski, & Douglas-Jones, 2018). Across the diversity of start-ups and small companies that we studied, we found that some developers postpone ethical decision-making, while others take it to be their responsibility to face them.

Building a start-up is not an easy undertaking. Founders are under enormous pressure in a world full of uncertainties and unknowns. There is little wiggle room for ideals and principles when the needed trade-offs concern the basic survival of the fledgling businesses which are pushed by their investors to deliver products. VIRT-EU has developed tools to map, consider and deliberate decisions in a structured and supported manner. We aim to support the kinds of arguments developers may need to marshal as they debate the ethical dilemmas they will inevitably encounter.

VIRT-EU ethical toolbox

Policy efforts such as the General Data Protection Regulation (GDPR) aim to protect the fundamental rights of European citizens with respect to data processing, making explicit high-level European ethical considerations. Yet, our research shows that without interventions that are relevant and appropriate to the social milieu of technology developers (Ustek-Spilda, Powell and Nemorin, forthcoming) – including impact assessments – such legal provisions risk becoming tick-box exercises. VIRT-EU addresses this problem in the following way. First, we have produced a tool that goes hand in hand with the GDPR providing a means for a different kind of impact assessment – not only concerned with privacy but also with social and ethical impacts. The Privacy, Ethical and Social Impact Assessment (PESIA) fits in with the assessments already familiar to both developers and regulators and mandated by the GDPR, but goes beyond compliance by providing a means for broader reflection.

Second, we created a suite of standalone tools to support ongoing deliberation and decision-making throughout technology development, necessary in a field characterised by rapid change. These include immersive explorations of value conflicts, ethical mapping of values, conflicts and compromises that emerge and evolve over time, methods for identifying mismatches between values and material choices in development processes. These tools are conceptualised on a foundation of our practical theory of ethics, which integrates three different yet complementary ethical traditions and provides an accessible language for those unfamiliar with social and moral philosophy. This suite of tools will be available at the end of the project for open access download from the project website maintained by the Open Rights Group.

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Irina Shklovski
Associate Professor
IT University of Copenhagen
Tel: +45 721 85 363
irsh@itu.dk
virteuproject.eu
www.twitter.com/VIRT_EU

VICTORIA PROJECT: How can video analysis facilitate investigation of criminal and terrorist activities?

VICTORIA stands for VIDEO ANALYSIS FOR INVESTIGATION OF CRIMINAL AND TERRORIST ACTIVITIES. It is a Horizon 2020 EU Security Project, which is developing robust and accurate video analysis technology to boost the law enforcement agencies' investigative capacity

Video material collected and analysed by law enforcement agencies (LEAs) has become a critical component in legal investigations following a series of major criminal acts and terrorist attacks.

On one hand, the amount of video data is continuously increasing with the rapid deployment of video equipment, surveillance cameras in public and private areas, body-worn cameras of police forces and smartphones or digital cameras used by bystanders. Indeed, we know that even criminals or terrorists themselves post videos on the Web that they have recorded during their acts.

On the other hand, and in spite of this growth, the video investigation work is still mostly carried out manually by the LEA officers. These current practices are too resource-intensive to handle the huge and steadily increasing volume of videos that need to be analysed. Consequently, post-event extraction of vital first clues from videos takes a substantial amount of time, causing further delays that no one wants.

There is without question an urgent need for efficient tools that can assist the LEAs in their daily video investigation tasks. Tools that can help them process the huge volume of video material with less effort and find clues and evidence faster. The urgency of addressing this need has become particularly clear after the wave of terrorist attacks that have hit several European countries since 2015.

The three-year EU-funded project VICTORIA, launched in 2017, is addressing this need. By the end of the project in April 2020, the consortium will deliver an ethical and legally compliant Video Analysis Platform (VAP) prototype that will accelerate the video analysis tasks of LEAs.

Developing technologies that meet the real operational needs of LEAs

As legal investigation videos are kept confidential by the LEAs, the VICTORIA consortium with its partnered LEAs, selected six operational scenarios, covering the majority of cases encountered by the different LEA units in Europe, with various levels of importance, i.e. from police surveillance to terrorist attacks. These scenarios and their variations were then staged and filmed with actors, using alternative light and weather settings and with camera resolution and video quality normally encountered in real conditions. Once filmed, these video datasets helped fine-tuning and testing the VAP and the algorithms throughout the project.

The VAP integrates a set of robust, accurate and advanced video analytics modules that have been developed, based on the specific needs of legal investigations. Among the topics covered are generic objects analysis, people-centric analysis, audio analysis and vehicles-centric analysis. The modules, accompanied by 4D crime scene reconstruction technology and advanced metadata querying mechanisms, integrated into the VICTORIA Video Analysis Platform enable investigators to easily navigate through a vast amount of video material. This enhances capability in LEAs daily investigation tasks, improving response time for their operations, solving crimes more rapidly and therewith protecting potential new victims.

Indeed, the VAP is offering a unified human-machine interface and is based on big data technologies that are both scalable and open. Additionally, third parties can integrate their analytics into the VAP with minimal effort, extending the capabilities of the platform even further.

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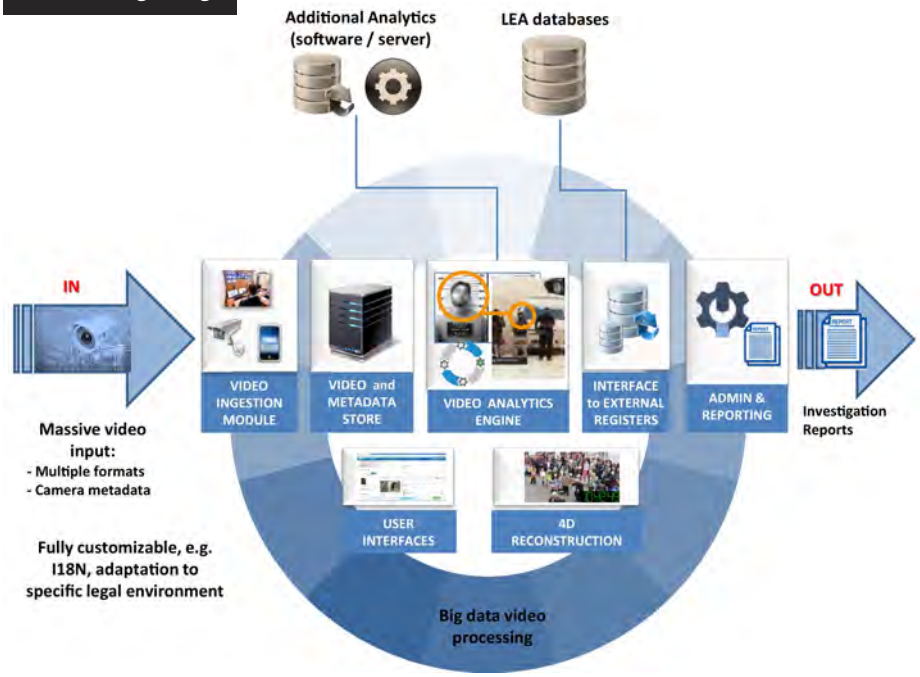

High-level VICTORIA Platform Concept

After more than two years of work and several workshops with project technical partners and LEAs, the VAP is now ready to be deployed at the project LEAs' premises (Spain, United Kingdom, Romania and France).

Following the final training workshop of the LEAs, the field trials carrying on from mid-September 2019 to end January 2020, will provide substantial and important feedback on the performance of each technical component and the usability of the last version of the VAP in real case scenarios. One of the addressed topics will be to evaluate how the daily work of the end-users has been supported by the VICTORIA platform. A roadmap of new developments and improvements needed in the future will be defined to pave the way to a successful continuation of the VICTORIA platform developments.

Lastly, to encourage even further development and demonstrate how open and flexible the VAP is and how it has been designed to support analytic tools from third parties with varied features, VICTORIA has launched its Analytics Contest. Audio and video analysis technology developers are invited, starting from 2nd December 2019, to propose and/or integrate their algorithms, to be benchmarked with the VICTORIA video datasets, into the VAP.

The main positive societal impact of VICTORIA will be the improved protection of the citizens against crime and terrorist activities, thanks to the enhanced video investigation capability of LEAs, enabling them to set-up targeted operations to stop offenders and provide evidence to support criminal charges. The investigation of an increased volume of video material will potentially contribute not only to convict offenders but also to release wrongly accused people.

VICTORIA avoids negative perception from the public, such as the "Big Brother is watching you" syndrome because the project does not target surveillance applications but rather post-event investigations carried out in the context of specific crime and terrorist activities. Therefore, solving more criminal cases and accelerating legal investigations with VICTORIA will reinforce the confidence of citizens in their police forces.

An international conference presenting the VAP to LEAs and audio/video analytics developers will take place in Spring 2020. To learn more about the upcoming Analytics Contest and the final conference, please visit our website (https://www.victoria-project.eu/).

The VICTORIA project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 740754.

VICTORIA
VIDEO ANALYSIS FOR INVESTIGATION OF CRIMINAL AND TERRORIST ACTIVITIES

Dominique Wasquel
Dissemination Work Package Leader
VICTORIA PROJECT
Tel: +33 1 5394 5473
victoria-coordination@eurtd.com
https://www.victoria-project.eu/
https://twitter.com/H2020Victoria

Why have one in five disabled adults never used the Web in 2019?

Bill Mitchell, Director of Policy – BCS, The Chartered Institute for IT explains why one in five disabled adults never used the Web in 2019

Article 9 of the UN Convention on the Rights of Persons with Disabilities states for people with disabilities to lead a full and independent life they must have equal access to information through the Web. This is a fundamental human right, yet here we are in the golden age of the Web and as far as accessibility goes it's in the dark ages, quite literally for someone with severe visually impairment. To quote[1] from Robert Stevens, Professor of Computer Science at the University of Manchester and someone who is blind: "There are no heroics; there is no winning through against adversity. There is, however, getting on with it. One takes one's opportunities where one can."

Web accessibility is where technology can play a key role in ensuring those opportunities exist. However, ONS data[2] collected in 2019 showed that 22% of disabled adults have never used the Web, compared to 9% in the general population who've never used the Web. It seems reasonable to suppose this is in large part due to unacceptably poor accessibility of Web services, rather than a lack of desire by disabled adults to use the Web. This is a major concern as interaction with healthcare and social services will gradually move to being offered only online in the long-term. Lack of accessibility in websites is a major barrier for disabled adults being able to have full participation in a digital society.

The new government Web Content Accessibility Guidelines[3] (WCAG) for public sector websites and apps that are to be enforced through new regulations are a welcome and positive move towards improving accessibility. We will need to closely monitor whether these result in a step change in overall website quality in addition to monitoring technical compliance. We also need to work with public service website developers to help them understand the needs of our diverse communities and how best to improve the overall quality of the user experience and move beyond minimal regulatory compliance that the new regulations will require.

In essence, the new government regulations are addressing the issue of ensuring website functionality is accessible. This is essentially a technical remedy to make sure online functionality is accessible to everyone. Functional accessibility is one aspect of wider concerns about ensuring online public services are truly inclusive. In other words, they are necessary but not sufficient for our public services to be truly inclusive.

"The new government Web Content Accessibility Guidelines (WCAG) for public sector websites and apps that are to be enforced through new regulations are a welcome and positive move towards improving accessibility. We will need to closely monitor whether these result in a step change in overall website quality in addition to monitoring technical compliance."

What's also important if we really want to improve real inclusivity, is to have a comprehensive range of online public services that give the maximum help possible to vulnerable and disadvantaged groups to become fully engaged citizens. Providing the most help possible includes ensuring we have absolute trust in the services we access to be fair, to treat us all as valued members of society and be absolutely reliable at all times.

We need to think about how Web accessibility is part of the overall accessibility problem within a public service. Consider a recent example of the complexities around providing public services through the Web. Recently the Guardian newspaper reported[4] a scam in which criminals obtained social security claimants' personal details, sometimes by posing as Department for Work and Pensions (DWP) staff, to make bogus online applications for universal credit. This illustrates how some vulnerable

individuals through lack of understanding of complex social security regulations, the risk structures in place in financial institutions and lack of access to trustworthy independent support can be criminally exploited. Now imagine that scenario for someone with a disability, trying to understand through an online public service what's gone wrong, how to get help and how to deal with all the agencies that are possibly going to be involved in sorting out the mess, if they even can sort out the mess.

The technical regulations being introduced to implement WCAG are absolutely essential as a very basic first step in ensuring Web access is equal for all, but access doesn't just mean readable fonts or carefully designed HTML 5.0 layout. We must all do our part to help build public services that genuinely provide the best possible service that the 21st century Web can deliver for everyone. ■

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Bill Mitchell
Director of Policy
BCS, The Chartered Institute for IT
Tel: +44 (0)1793 417 417
www.bcs.org
www.twitter.com/bcs

Digital accessibility: What's hidden in our devices?

Mike Taylor, Senior Accessibility Analyst and Comms and Training from Digital Accessibility Centre, highlights what hidden features can be found in our digital devices in order to promote accessibility

Digital Accessibility Centre (DAC), is a not for profit organisation which tests digital products such as software applications, websites, native apps etc., to ensure compliance with web standards. They also provide training and bespoke e-learning modules covering digital accessibility.

They employ testing teams comprised of users with various access requirements, such as users who are blind, who have dyslexia, low vision and limited mobility to name a few. DAC's team of accessibility analysts, trainers, technical support and web developers supplement user findings by carrying out expert compliance audits using skill, experience and a range of tools and provide a comprehensive report to their clients identifying issues and providing solutions to help make digital products more accessible for everyone.

What's hidden in our devices?

Deep in our phones, computers, TV's and tablets, is a series of menu items which provide a feature set which makes most items easy to use. If you or someone you know needs specific background colours, font size, audio output, or interacts with their device in a specific way such as using a third-party keyboard, there is a good chance they have additional access requirements. In this instance, the feature set listed under the 'accessibility' menu of your device is a good place to start.

What will you find?

You will find a list of options, designed to make using your device easier, and having such tools can only open up a world of possibilities for the end user. Tools which might seem pretty cool to some people, are the same tools that mean the difference between being able to use a device or not for others.

As a totally blind person, I use a screen reader, which causes a device to announce what is on screen, which allows me to use my phone, laptop and TV. Screen readers are just one example of an accessibility feature now available on many devices. When talking to people about accessibility and describing some of the features they will have on their devices, the level of surprise because a person didn't know what the additional functions did is always interesting.

Some of the key features you are likely to find on a wide range of devices today are:

- Screen reading software.
- Magnification options.
- Font and colour adjustment, and hearing aid compatibility as well as Switch control.

Knowledge is power

You may be reading this article and feeling confident that you have no need for such features as switch access, which enables users with limited mobility or a cognitive difficulty to use their device. You may not feel the need to change the font, colours or magnification of your device screen; however, being aware of these clever tools may help you in the event that a friend or relative, or even a colleague should need them.

Longer life expectancy means that at some point, it's likely that more people will rely on built in accessibility features, and will need to utilise the various items I briefly mentioned above.

The Disability Living Foundation key facts information page indicates that:

- In 2016, there were an estimated 308 people of a pensionable age for every 1,000 people of a working age. By 2037, this is projected to increase to 365 people [14]
- There are now 11.8 million people aged 65 or over in the UK. The number of people aged 65+ is projected to rise by over 40 per cent (40.77%) in the next 17 years to over 16 million. By 2033 the number of people aged 85 and over is projected to more than double again to reach 3.2 million, and to account for 5 per cent of the total population [15]

- 1.6 million people are aged 85 or over. The number of people over 85 in the UK is predicted to more than double in the next 23 years to over 3.4 million. [16] *Taken from The Disability Living Foundation Key Facts page:*

https://www.dlf.org.uk/content/key-facts

Some tips about using your device with built in accessibility features

Once an accessibility feature is set up for use, its generally a case of set and forget. The only way this might change is by additional customisation from the user of the device, or having a handset or software update. It is possible to set up short cuts to access various accessibility features, so it may be worth doing some research, asking a friend or relative, or the company you are buying the device from about which accessibility options are available.

Many manufacturers of mobile, tablet, or computers offer cloud storage facilities, it's worth remembering that it's not just documents and photos which can be stored here, some accessibility settings can also be saved. If you are updating your device handset for example, it's a good idea to back up to the cloud before erasing your content, and when going through the set-up of your new device, you can turn on accessibility features and restore your previous content, which will include your settings.

What about voice assistants like Siri or Google?

The 2 main manufacturers of smart phones include voice assistants on all their devices. Apple and Android have made life easier by allowing users to implement Siri and Google voice respectively, and windows also contains Cortana. There is no doubt a discussion to be had about weather voice assistants fall under the category of accessibility features, however, I would suggest this depends on the person using them, as everyone will no doubt have different reasons for using them; and what is convenient for one individual, is a game changer for someone else.

My personal use of Siri for example, is purely to enable me to do things quickly, like calling someone, or setting a timer. Siri is great, but I am unable to use social media, remove and install apps, and customise the layout of my home screen using Siri; So again the view is subjective.

Getting online

Using the various features available, it is not only possible to access the device settings, customise your screen, and access social media and messaging functions, as the increased technology now enables users to get online. No matter if using apps, or websites, content can now be viewed as long as the material is coded to the Web Content Accessibility Guidelines (WCAG) standard. If you are new to the term WCAG, it's a set of guidelines which all content authors and web developers should adhere to, in order to allow as many people to get online as possible.

The future of built-in accessibility features

While it's difficult to predict future developments relating to technology, it's clear to me that we are already witnessing a shift in how users access and use the technology on their devices. The increase in such features mean that users have more choice when purchasing a computer, mobile or TV, which can only be a good thing moving forward.

DAC Digital Accessibility Centre

Mike Taylor
Senior Accessibility Analyst and Comms and Training Manager
Digital Accessibility Centre
Tel: +44 (0)1792 815 267
mike.taylor@digitalaccessibilitycentre.org
www.digitalaccessibilitycentre.org
www.twitter.com/DACcessibility

The potential of artificial intelligence in the public sector

Here, we find out some ways in which the GDS is leading digital transformation in government, including the priorities of the organisation's Interim Director-General and the enormous potential of artificial intelligence in the public sector

In essence, the Government Digital Service (GDS) helps government work better for everyone by leading digital transformation.[1] In August 2019, Alison Pritchard was named Interim Director-General of the GDS[2], now that Kevin Cunnington has taken on a new role promoting government services around the world.[3]

Alison recently shared her journey in government so far and discussed what she looks forward to delivering over the coming months. Long before she joined any government department, Alison already had experience of meeting user needs and delivering more for less. Alison explains that she was given the chance to run the garden bar at the family pub at the age of eight. While she was only dealing with soft drinks and nibbles, this experience taught her that first, people appreciate good service. Alison elaborated on her thoughts at this point.

"They liked to be listened to, they liked to be served quickly and efficiently. They also like to get the best value for money; it turns out asking them how much change they need generates some interesting revenue outcomes."

> "PwC estimates that AI could contribute $15.7 trillion to the global economy by 2030. The UK is in the top three countries globally in the development of AI technologies and this strength puts us in a prime position to unlock this projected global growth. The same estimates indicate AI could increase our productivity by 14.3% and grow our GDP up to 10.3% by 2030."

Alison was a systems analyst and systems designer at the Ministry of Defence (MoD) and she also worked in the Equalities Office, for example, heading up the latter for the roll-out of gender pay gap reporting. Amongst

other roles, she has an impressive background in various government departments, such as the Department for Environment, Food and Rural Affairs (Defra), HM Treasury, the Cabinet Office and the Department for Digital, Culture, Media and Sport (DCMS).

Her current aims include accelerating momentum on the GDS's business, including all the vital tasks around EU Exit. While this is a huge part of GDS's efforts, she also outlined her bold digital goals.

"We also need to build our future, setting the boldest goals for digital advancement across government, a big push on data analytics, digital identity and embedding of innovation. To do that, we need the right resource, capability, powers and influence.

"And I have a duty to help land permanent leadership of GDS in a way that we don't miss a beat and so we can springboard into the future state for digital government." [4]

Artificial intelligence (AI) in the public sector

Back in June 2019, the GDS and Office for Artificial Intelligence (OAI) published joint guidance on how to use and build artificial intelligence (AI) in the public sector. In essence, this guidance covers how to assess if using AI will help you meet user needs; how the public sector can best use it and; how to implement AI fairly, ethically and safely.

In the Ministerial Foreword to this, we find out that daily, AI is changing the way in which we experience the world and we already use it to locate the fastest route to get home, filter out spam emails or alert us of suspicious activity in our bank accounts, for example. In closing, I'll leave you with some words from the Ministerial Foreword which highlights the importance of AI to the public sector, the impact it could have on the global economy and how it will help GDS deliver more for less, the latter point which we alluded to near the start of this article.

"The UK government recognises the importance of this technology's development to both business and the public sector. Indeed, Artificial Intelligence and Data was named as one of the four 'Grand Challenges' in the Industrial Strategy White Paper, which are global trends that will transform our future and contribute to the government's long-term plan to boost productivity in the UK.

"PwC estimates that AI could contribute $15.7 trillion to the global economy by 2030. The UK is in the top three countries globally in the development of AI technologies and this strength puts us in a prime position to unlock this projected global growth. The same estimates indicate AI could increase our productivity by 14.3% and grow our GDP up to 10.3% by 2030.

"There are huge opportunities for government to capitalise on this exciting new technology to improve lives. We can deliver more for less, and give a better experience as we do so." [5] ■

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Open Access Government
editorial@openaccessgovernment.org
www.openaccessgovernment.org
www.twitter.com/OpenAccessGov

Artificial intelligence technologies (AITs): Transforming public policy

Dr Emma Carmel, Associate Professor, University of Bath, offers her expert insight into the use of artificial intelligence technologies (AITs) within government to transform public policy

Automation of human decision-making through the use of artificial intelligence technologies (AITs) in government has the potential to transform the nature of public policy, politics and statehood in a democratic society. AITs may fundamentally alter where decision-making takes place, as well as how, by whom and when. It opens a radically new field of political and institutional relationships in public policy and services. These developments significantly challenge our systems of political responsibility and accountability, and create potentially new roles for state, political and private sector actors. Nor is this a distant future: Automation and the use of machine-learning in governmental decision-making is growing rapidly.

AITs, automation and public policy

Automation has for more than a century in fact been a commonplace feature of government decision-making. It is expressed in forms, checklists, conditionality criteria, decision rules, and regulatory guidelines that create smooth-running government and bureaucratic machines. So far, so normal.

What is different now is that the diverse new forms of computerised automation – from algorithmically automated decision-trees, to probabilistic risk evaluations, to unsupervised machine-learning – signal a qualitative shift in the meaning, significance and practice of automation. AITs promise efficacy, accuracy and reliability in public policy. Yet in practice, they risk rigidity, de-contextualisation and opacity in decision-making.

Indeed, AITs may not always be appropriate, effective or available to use in government decision-making. The current wave of AIT adoptions raises problems of: Explainability and accountability in automated decision-making; how uncertainty and context are accommodated when decision recommendations are automatically generated through risk-based calculations; bias, and the capacity of policy-makers and front-line staff to interpret AITs into their professional judgement.

When considering the social, political and ethical implications of introducing and managing the use of AITs in public policy, it is essential to take account of two things. First, the diversity and limits of the technologies themselves, and especially the variety of automation that is now available. Second, the need to explicitly manage the complexity of decision-making – that increases, rather than decreases – when they are adopted in practice.

Types of automation using AITs

1. Single-stage algorithmic automation can be based on pre-defined decision-models, using regulatory criteria for example. This is often based on 'imperative programming', of the classic step-by-step, 'if…then' type. By itself, this not AIT-based automation. However, where an algorithm is programmed to produce a particular outcome (decision), but not instruct the software about how it should reach that outcome, this might use classic AI-based 'declarative programming';

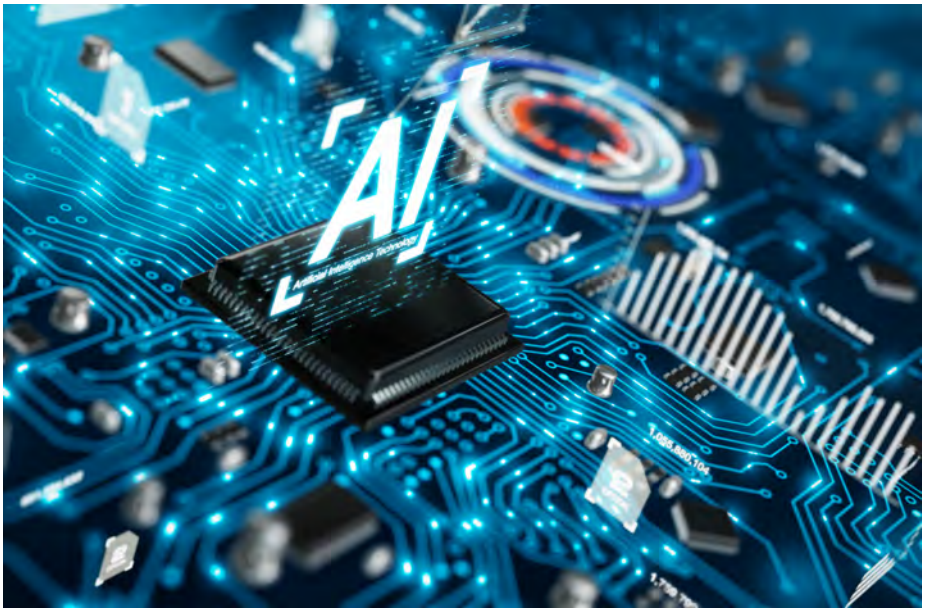
2. Two-stage algorithmic automation uses machine-learning on data from previous decisions to generate a model of those decisions. This model is then used to design an algorithm that is applied in actual type (1) automation. Like all machine-learning, this type of automation is in practice heavily dependent on the quality, detail, appropriateness, and format of the data used for training the algorithm. Most technological developments are in this area;

3. Concurrent automation uses machine-learning and/or neural networks in 'real-time' to make decision-recommendations. As such, the decision-recommendations use past and current data to inform the risk-based recommendation;

4. Autonomisation is where machine learning and neural network systems make decisions based on patterns in data, and these decisions have policy and legal effect.

AITs and existing decision-making processes

AITs involve increased complexity and



transformation in the importance of different parts of decision-making processes, even though the decision to act on recommendations in most cases remains in the hands of humans. Key elements of AI-based policy decision-making include:

- Decision to adopt AITs, including impact assessment and ethical review;
- Procedures for, and terms and conditions of, procurement;
- Model, algorithm, system design and iteration;
- Data selection, cleaning, harmonisation, storage and formatting, requiring improved data collection for all government systems;
- Learning-system functioning in practice, its application and outcomes in specific service contexts;
- Evaluation and audit of system adoption, relevance, and use over time, in specific services and wider institutional and policy settings;
- System revision and termination.

As such, AITs are being introduced into bureaucratic processes and institutional contexts that are shaped by human, organisational, digital, temporal and financial resources and capacities. These can generate conflicts between:

- Technological demands for speed, data, and sustainable computing capacity;
- Policy and legal requirements for fair, rigorous and legible decision-making;
- Human, technological and financial resource capacities that promote sustainable and accessible decision-making over the long-term.

These conflicts involve a wide range of political actors. Senior public servants who approve, procure and regulate AIT adoption and use; public technology and data specialists who oversee the design, use and revision of the technologies; and corporate actors who develop, sell and provide AITs to governments; as well as wider policy stakeholders and citizens who encounter AITs, whether knowingly or unknowingly in their day-to-day dealings with the state.

So what to do?

Policy leaders must urgently address the challenge of increased automation and particularly the use of AITs for government decision-making. There are five inter-connected priorities:

1. Draw on, develop, and make widespread use of the ethical frameworks around AIT adoption and use in government that have been emerging internationally in the last 12-18 months;

2. Design new processes to manage accountability between data specialists, technology designers and professional/'front-line' teams;

3. Revise and clarify procurement processes specifically for AITs, particularly around contractual obligations for openness, rigour and accessibility;

4. Train non-specialist staff in interpreting the risk-based calculations of automated systems, and the limits of AIT-based decision-recommendations;

5. Acknowledge their own knowledge gaps and reflexively engage inter-disciplinary teams to oversee AIT design, adoption and use, both generally, and in specific policy sectors.

UNIVERSITY OF BATH

Dr Emma Carmel
Associate Professor, & Director, MSc in Public Policy
Faculty of Humanities and Social Sciences, University of Bath
Tel: +44 (0)122 538 4685
https://researchportal.bath.ac.uk/en/persons/emma-carmel/publications/
www.twitter.com/EmmaKCarmel

Overcoming obstacles to digital transformation

Darren Watkins, Managing Director of VIRTUS Data Centres explains his thoughts on overcoming the obstacles to digital transformation

In the UK, there is an increasing number of government transformation programmes underway, designed to manage the introduction of new technology and associated changes. Whether it's an online portal for tax returns, chatbot apps for customer interactions or large-scale smart city services, technology is now a vital part of public life. Today, there are at least 19 such digital transformation programmes in operation, together costing the taxpayer almost £38 billion.

Despite the UK Government's clear commitment to using technology to improve services and save money, it's accepted that squeezed public sector budgets and complex requirements make adopting digital technologies on a large-scale difficult. Compounding the complexity in this highly regulated world, any tech initiative must be trusted, secure and reliable.

However, whilst the government recognises that digital transformation programmes are "extremely challenging"[1] the risks in not transforming are also significant, jeopardising the future quality, value for money, relevance and quality of public services.

A smarter approach

Digital transformation is necessarily complex and high-risk. However, many reports[2] show that the UK is still at the early stages of its digital journey, where the primary aims are to cut costs and make savings, rather than to embrace the truly transformative potential of digital disruption.

At the moment, there is a focus on discrete initiatives, such as a move to more digital communications with the public, or workplace programmes that aim to provide government workers with digital skills. What's needed is a broader strategy that harnesses the power of technology to provide for all in an inclusive, accessible and sustainable way - it's here that the "smart city" approach comes in.

There are a range of definitions of a smart city, but the consensus is that smart cities use IoT sensors, actuators, and technology to connect components across the city. This connects every layer of a city, from the air to the street to the underground. It's when you can derive data from everything that is connected and employ it to improve the lives of and communication between citizens and the government that a city becomes truly smart.

> "A broad and collaborative approach to smart living is vital to public sector digital transformation, but truly transforming government through the power of digital technologies will be a journey and schemes like those in Helsinki and beyond are only possible when the IT Infrastructure is in place to support them."

In Helsinki's Smart Kalasatama district, for example, connected applications take centre stage. Its residents are the initiators and testers of new technology and smart services – and the local authority reports that it wants to become so efficient that its residents gain one hour of extra time per day. Smart projects in the district include parking places with car charging facilities, as well as automated waste collection systems that reduce the traffic of garbage trucks by up to 90%. Added to this, the municipality is embracing smart grids and real-time energy monitoring pilots that aim for a 15% reduction in energy usage, and apps that plan the most efficient traffic routes with any type of transportation method.

Businesses too are benefiting from a smart city environment, seeing greater efficiency in their operations and ultimately better service to customers. Improved

Darren Watkins, Managing Director of VIRTUS Data Centres

traffic management, for example, with better supply chain and logistics for online retailers, whilst smart lighting may improve footfall around physical shopping centres, boosting sales for local businesses.

Getting the basics right

A broad and collaborative approach to smart living is vital to public sector digital transformation, but truly transforming government through the power of digital technologies will be a journey and schemes like those in Helsinki and beyond are only possible when the IT Infrastructure is in place to support them.

Digital infrastructures must be able to physically link dispersed machines and sensors, so they can exchange information in real-time – and to tap into the potential value of big data, interconnections between people and applications, data, content clouds, and networking needs to be seamless.

Being able to store data effectively and access and interpret it as meaningful, actionable information, is vitally important to organisations across the board. It will bring huge advantages to the institutions that do it well. However, the implications of not getting it right are significant. Failures in the network could result in transport systems being shut down, power outages and a huge disruption to citizens.

The right infrastructure to support the demands of technology- powered living means lots of connectivity, storage and computing power, and this is facilitated by the data centre.

When it comes to getting the data centre strategy right, government departments and local authorities have significant challenges to overcome. Most will have to mix the old and the new - dealing with legacy infrastructure as well as creating new facilities. For some, this might mean that traditional "core" connectivity hubs will have to work alongside smaller data centres optimised for edge computing. As more and more applications are required to service immediate engagement – such as media streaming or payments – data centres must be placed correctly for this type of need too.

Ultimately the extensive nature of digital transformation needs something beyond a company or government department's in-house storage capabilities, and this presents significant opportunities for data centre providers to help. Already we are seeing many government departments and wider organisations are turning to third-party IT suppliers to help them navigate their data centre strategies – engaging with colocation facilities that provide the best in interconnectivity, flexibility and scalability – and this is a trend which looks set to continue and grow.

So, for any wide-scale digital transformation to succeed, it's vital to start with getting the basics right – ensuring the impact of new technologies on infrastructure is managed.

Digitally savvy public sector organisations must look at the infrastructure. Indeed, it's no exaggeration to say that as our UK cities grow, whether they thrive and deliver a good quality of life to millions of citizens is down to the IT backbone that underpins them. ■

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Darren Watkins
Managing Director
VIRTUS Data Centres
info@virtusdcs.com
www.virtusdatacentres.com
www.twitter.com/VirtusDCs

Saving on your digital transformation strategy

Rob Fotheringham, Managing Director at Fotheringham Associates, offers advice on how to get the most out of your digital transformation strategy with the potential to save money on unnecessary investment

Digital transformation typically demands significant technology investment with a shopping list that can include an integration capability, workflow, data analytics and of course a customer engagement platform.

Before you rush off and start spending, we suggest that you take a little time to potentially save yourself money and elapsed time. We have used a set of architecture techniques with a number of councils and discovered significant ICT assets languishing at the back of their metaphoric dusty cupboards.

It should be understood that I am not pointing the finger here, finding unused hidden treasure is very common for us. I managed architecture teams in local government for a number of years and know all too well the effects of a sharp change of focus for the organisation, sending certain technologies and projects to the back burner. I have also known suppliers to sell bundles of software components that contain an 'extra' that unknowingly to them can turn out to be a nugget of gold in the future.

At Fotheringham Associates, we work with organisations to help understand and unlock their business, technology and internal capabilities to meet the challenge of digital transformation. In the first of four articles on the practical use of enterprise architecture I have sought to provide a cautionary tale and a nod to our articles in previous issues "Observations on pragmatic digital transformation" and "Finding a dividend for transformation".

Potential benefits

Let us consider the potential benefits for this kind of exercise for a moment. The obvious money saving is by re-using the technology that you have, but even if you do need to make an investment to extend its use you should find that the power relationship with the supplier has changed. As you have discovered something you didn't know you had then you could discard it and buy new as you thought you would be forced to do.

However, when communicated to the supplier in an appropriate way it is normally enough to obtain a significant discount on the incremental cost you need to pay in order for them to keep the maintenance, subscription or even market share ticking over.

If we look at the saving in time this is the avoidance of long-winded procurements. For strategic software you may well be looking at an OJEU process which as we know is even difficult to complete within four months. In the happy path of re-using existing software you need no procurement at all, saving the whole four months.

However, if you do need to procure some kind of extension to the capability, as you have already made a significant investment in the software, procurement options such as the negotiated route and waivers are

available as legitimate ways forward. This could still save you at least a couple of months from your transformation roadmap and the quicker realisation of benefits.

"At Fotheringham Associates, we work with organisations to help understand and unlock their business, technology and internal capabilities to meet the challenge of digital transformation."

What do you need to do?

You need to create a comprehensive view of your application landscape, capturing information on the application's function (at a high level), underlying technology, business usage, cost and licensing information. It should take you no more than four to six weeks to gain a complete enough picture to begin shining a light into those dark cupboards.

Having conducted this kind of exercise across many organisations we know what we are looking for and by using a set of accelerators we quickly establish an audit of the application landscape. The application catalogue provides a standard way of describing the applications, capturing vital attributes and information that we can analyse later.

Whilst these catalogues can run to 200-500 entries we can deploy a further accelerator to provide focus. The reference architecture that we use provides a way of categorising and grouping applications aligned with their function, for work with councils it has previously discovered council applications to further speed up the mapping process. This mapping also provides a foundation for a number of enterprise architecture led activities which we will discuss in subsequent articles.

Examples from our casefiles

At one unitary council we discovered an enterprise class integration technology that had been bought as part of a deal bundle a few years previously. After a version upgrade this proved itself to be capable of enabling business processes to link applications and work across departments. This discovery saved in the region of £300,000. At the same client we also found spare licences and unused modules for a major Enterprise Resource Planning (ERP) suite. Whilst ERP systems may not be 'on trend' these days they do typically constitute a major investment and therefore should be made to pay their way. The unused modules were dusted off, licensing was restructured (for a fraction of the true cost) and the ERP system is now the critical customer engagement platform in the council's digital transformation.

At a second unitary authority our project again found unused integration software gathering cobwebs. The council has now developed in-house skills and it has been used to integrate the Oracle cloud-based HR system and the onsite user directory automating joiner/leaver processes saving considerable time within the business. It is also now the default means of integrating systems across the council.

Additionally, we also discovered a modest investment in a useful Office 365 add-on that was bought as part of a proof of concept the year before. Although this technology is not the answer to the strategic workflow needs across the council it was clear it could be used as a tactical response to automating work across back office departments. Requiring limited training, in-house development was embraced and it is now contributing to the transformational benefits column.

What is clear from this experience is while you will undoubtedly have to invest in technology in order to achieve your transformation goals, by first fully understanding what you already have, including looking at its untapped potential, you could seriously reduce the cost and the time spent on lengthy procurements. As a bonus your cupboards will have had a spring clean.

Rob Fotheringham
Managing Director
Fotheringham Associates
Tel: +44 (0)780 966 8792
rob@fotheringhamassociates.co.uk
www.fotheringhamassociates.co.uk

The challenge of maintaining an up-to-date well-patched end-user device environment

Maintaining an up-to-date well-patched end-user device environment has been a challenge for many organisations, but with a modern approach, it does not need to be, Sam Newman, Technical Director of OGEL IT LTD explains how

Companies are becoming increasingly concerned about the threats to the security of their data assets and are looking for help in ensuring they have taken appropriate steps to mitigate the risks. Some organisations are hesitant to patch or upgrade their systems, as they are so worried about the potential operational impact that they end up not doing it at all.

"We work with our customers to design an autonomous patching cycle for their Windows estate that works for them by maximising exposure to early release issues and minimising the potential impact on business operations."

You may have heard the term Evergreen IT, if you haven't, it's been around for several years and the term is used to capture an approach to the provision of loosely coupled services that are designed to always be up to date. In the past, IT services have been engineered around a stack of software with several layers of integration resulting in an unnecessarily complex solution that can make it difficult to update or costly to replace certain elements. Adopting a stack of loosely coupled services counters this by using software and services that are self-contained and accessible via standard interfaces, such as web browsers to minimise or remove the requirement for complex integration and simplifying the move to an alternate product.

The move to modern cloud services that are updated and maintained by established organisations largely removes the decision to upgrade out of the consumers' hands, which can be worrying but helps ensure exposure to new vulnerabilities are minimised across back end systems. This, however, does not resolve the same issue with the client operating systems and associated software packages as these are not typically treated as self-contained and have dependencies across multiple systems.

Windows 10 and Office 365 click to run goes a long way to extending this evergreen IT model out to the desktop and with the right implementation and operational procedures, can create a secure and easily maintained environment. Microsoft Office 365 delivers several well-known services via both a browser and through the client installed applications and handles all the back-end management of Exchange, SharePoint and file services and so customers don't have to. Windows 10 and the office client are designed to be automatically updated on a regular basis and will adopt this approach by default.

Embracing the automatic updates is critical for ensuring the most recent

vulnerabilities are addressed, therefore, keeping organisational assets secure. There are many ways to manage the release effectively to minimise the risk of an update negatively impacting the business operation and this is all about preparing for the updates and identifying problems early. Creating a phased release strategy with key system owners early in the release scheduled helps move the testing burden from IT teams to the business reducing overheads and having suitable processes in place to capture and report issues early is critical.

OGEL IT has transitioned several customers to Window 10 and Office 365 helping them to embrace the 'Evergreen IT' strategy, resulting in a significant increase in the update compliance of their end-user devices estate and a reduction in the overhead on operational teams to patch and maintain the environment. We work with our customers to design an autonomous patching cycle for their Windows estate that works for them by maximising exposure to early release issues and minimising the potential impact on business operations.

> "Embracing the automatic updates is critical for ensuring the most recent vulnerabilities are addressed, therefore, keeping organisational assets secure."

We encourage our customers who have previously outsourced the management of their end-user estate to external providers to take a more active role in the management of their devices which improves the quality of the service to the end-users and reduces costs. Where organisations don't have the capability in-house, we work with them to help build it up by providing a flexible support service that can adapt over time as the internal capability grows or where they just don't have the headcount or desire to take on the management we have done that for them.

Our entire team started their careers in IT support and have been in receipt of poorly designed solutions and services that don't consider the associated operational overheads and, therefore, everything we design and deliver takes this into account and we take great pride in the quality solutions and services we deliver to our customers.

If you would like to find out more about what we do and how we can help you then please get in touch via email, phone or our website.

Sam Newman
Technical Director
OGEL IT LTD
Tel: +44 (0)1438 567 551
www.ogelit.com

4 Keys Steps to Cloud: From assessment to transformation

Here, UKCloud explains how businesses can take advantage of Data Centre Modernisation, whilst still focusing on their core business and avoiding key pitfalls of digital transformation

So, you've decided you'd like to reap the benefits of Data Centre Modernisation; reducing costs, increasing your operational agility and spending more time focusing on your core business. But you may be left wondering what you need to do, what approaches you can take and some of the key pitfalls to avoid.

You have realised that your organisation needs to adopt multiple cloud services – but that's a long way from where you are today. You are facing a myriad of existing systems, technologies and contracts that you need to disentangle. But you don't have the capacity or expertise to properly focus on turning your vision into an executable plan.

Without a coherent plan, your use of cloud is tactical and piecemeal. It's difficult to keep control of these new cloud services whilst also keeping your existing IT afloat. In effect, things are getting worse – and you need them to get better.

4 Key Steps to Cloud: High-level

Recognising these challenges, we have identified four keys steps that can simplify, de-risk and accelerate your journey to cloud as outlined below in Figure 1:

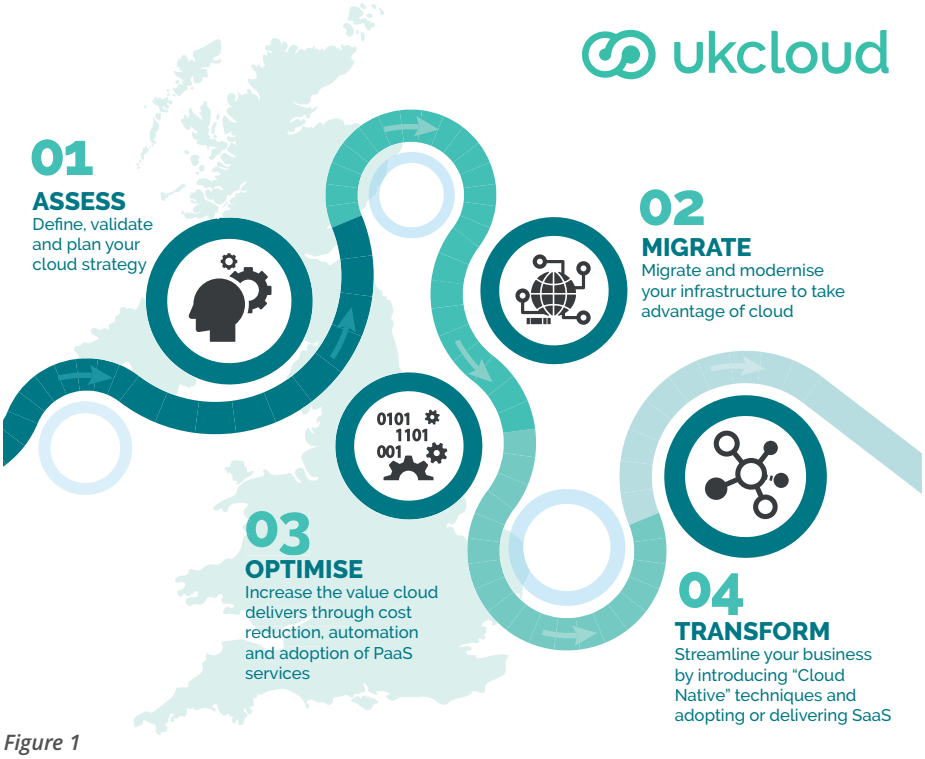


Figure 1

4 Key Steps to Cloud: Detailed

UKCloud provides a range of services at each step, that supports organisations as they progress their journey to the cloud. Figure 2. shows some examples of the type of work we recommend and progress with our customers.

How can we help?

Our team of multi-cloud experts are at hand to help you with a clear path to cloud, no matter where you are on that journey. UKCloud provide expert, agnostic, multi-cloud advisory through a structured, modular approach. Each stage is supported by a defined, outcome focused workflow that delivers tailored, high value output enabling organisations to adopt cloud with confidence.

Our services are designed to support the specific procurement, assurance, security and connectivity needs of public sector organisations. Our portfolio of products and services are available via G-Cloud and other popular public sector frameworks and support cloud-based transformation programmes end-to-end or via discrete phases dependent on your requirements.

Why UKCloud for Professional Services?

- Our methodology is informed by the 220+ digital transformation projects we have successfully completed within public Sector.

Figure 2

01 ASSESS	Concept | Feasibility | Strategy
	Assess maturity | Develop strategy | Validate strategy | Business case | Procurement support
	Designed for organisations without a clear cloud migration path, the cloud assessment service can help you clearly understand the cost of your existing IT investment, evaluate options for migration to IaaS, PaaS & SaaS services, and build business case / procurement material which help you get there faster. The service can be tailored to deliver just the specific items that your organisation needs.
02 MIGRATE	Design | Plan | Execute
	Service discovery | Transition planning | Service deployment | Workload replication | Service transfer
	Migrate critical business systems and entire datacentres from legacy silos to a new secure, hybrid multi-cloud platform. We will interview key business and technical stakeholders and deploy tools in your infrastructure to ensure we understand the criticality of your applications and how they interact with each other. Workloads can then be migrated in the right order, to the right platform and sized appropriately, ensuring all the benefits of a true hybrid, multi-cloud strategy.
03 OPTIMISE	Review | Enhance | Automate
	Cost assessment | Governance advice | Service automation | License reduction
	This service is designed for customers who have already migrated legacy technology to the cloud or for customers who have been using cloud for a while but are yet to realise the full benefits it can provide. UKCloud consultants will undertake an assessment of your cloud environment focussing on commercial, technical and security characteristics, then develop and execute work packages that deliver operational efficiency and cost savings.
04 TRANSFORM	Cloud-native | DevSecOps | Scaling
	DevOps | Containerisation | Infrastructure as code | Deployment pipelines | Multi tenancy readiness
	Cloud Native applications fully utilise features such as auto-scaling, message queues, object storage and containerisation. Using these services often requires a radically different approach to application development and deployment, this service provides the expertise to ensure your project goes smoothly and your team are ready to adopt new ways of working.

- Our agnostic, multi-cloud approach and experience ensures appropriate and efficient solutions for business needs: the right workloads, on the right clouds.
- Our team of experts provide pragmatic leadership and support that caters for the end-to-end cloud journey, spanning vision, strategy, migration and optimisation.
- Our approach supports transformation programmes of varying scale & complexity using flexible tools, templates, reference architectures and methods tailored to individual organisation needs.
- We focus on doing what's right and remain dedicated to our core values by developing digital services and products that underpin economic growth and support our public sector customers.
- Our people are all based in the UK and are government security cleared and vetted under the national police personnel vetting (NPPV) scheme.
- We ensure pace and certainty of outcome, with measurable business benefits achieved faster and with less risk.

UKCloud – Making Transformation Happen

UKCloud is dedicated to helping the UK public sector by delivering more choice and flexibility through safe and trusted cloud technology. We own and operate UK sovereign, industry leading, multi-cloud platforms which are secure, assured and located from the Government's Crown Campus.

Our team of multi-cloud experts are dedicated to helping our customers gain value from the agility and cost savings of a multi-cloud strategy and Making Transformation Happen – cheaper, faster, safer.

If you would like some advice as to how you could approach your cloud transformation project – please contact us on 01252 303 300 or pro-serv@ukcloud.com .

ukcloud

UKCLOUD Limited
Tel: +44 (0)1252 303 300
https://ukcloud.com/

Small changes: The secret behind public sector transformation

Martin McFadyen, Head of Public Sector, Virgin Media Business argues that small changes are the secret behind public sector transformation

Banishing pagers from hospitals and replacing them with smartphones and apps. Digitising the online civil money claims service, achieving 90% public satisfaction ratings. Sending civil servants on secondments to digital companies to learn from innovative cultures and enhance technological skills.

These small, almost imperceptible changes are driving positive outcomes across the public sector.

Since the Cabinet Office launched the Government Transformation Strategy in 2017, which covers everything from citizen-centric public services to ensuring government buildings have interoperable technology, promising progress has been made – and this should make public sector decision-makers and citizens very excited indeed.

Ultimately, if the Government Transformation Strategy is successful, civil servants will feel empowered to achieve their objectives much faster, and citizens will benefit from public services that make their lives easier.

While incremental and manageable changes are leading to successes, there's still more to do – especially when it comes to enhancing infrastructure and supporting modern working practices.

Embracing winning structures

Part of meeting the Government's ambitions is embedding a winning structure at the heart of digital transformation projects. By 2020, the Government plans to deliver at least 86 digital services using an end-to-end structure where members of the public can follow simple step-by-step online processes to achieve their goals.

Not only is this an example of positive digital change, but it also demonstrates the power of digitisation to make people's lives less stressful and more straightforward.

The Government has also adopted a structure for user verification, known as Gov Verify, which allows people to access 18 key central government services, including checking income tax on HMRC and claiming for a redundancy payment via the Insolvency Service. Unifying user authentication systems might seem like a small, routine change, but it's actually a major structural development that has delivered added convenience for users and, for example, has encouraged people to check their tax codes for accuracy.

While there has clearly been progress, the next step is for public sector leaders to focus on enhancing infrastructure. The importance of constant and secure connectivity can sometimes be deprioritised in the public sector – perhaps because networks are ultimately invisible forces.

However, it's crucial to remember that digitisation is ultimately driven by networks which not only process the data that drives public service delivery but also manage pressures on the system from customers and adapt bandwidth management accordingly. Moreover, these networks need to be secure, otherwise, they risk exposing confidential information and compromising the integrity of entire public services. Rolling out next-generation networks will be vital to delivering the next tranche of iterative improvements.

Combatting the remote working conundrum

One key challenge is responding to demands for remote working. By 2020, the Government expects 70% of departments to comply with the Smart Working Code of Practice written up by the British Standards Institute – which means they will need to update their technology to support flexible working for civil servants.

This is particularly complex for the public sector, as there are different levels of security to consider across different departments influencing the extent to which a 'Bring Your Own Device' (BYOD) policy could be introduced, for example.

However, there's no doubt that to attract top talent, support for remote working will need to be delivered – and a large part of that will involve empowering employees to access a corporate network while they are on the move. Delivering this is critical for an organisation, and public sector leaders should seek a strategic technology partner that can act as a co-pilot on this journey.

Overall, while there are encouraging signs, there's still work to be done to implement winning structures and deliver twenty-first-century services for citizens. The public sector needs to continually implement small changes, ensure data and knowledge are shareable and put power in the hands of people. ■

Martin McFadyen
Head of Public Sector
Virgin Media Business
Tel: +44 (0)800 052 0800
www.virginmediabusiness.co.uk
www.twitter.com/vmbusiness

What is data science in market research?

Data Science covers a range of different disciplines that are to do with the collection, analysis and reporting of data. Chris Cook, Managing Director, PAL Stats, offers his expertise to discuss what data science in market research is

The disciplines that are needed depend on the requirements of the project but include:

- Market Research
- Mathematics
- Statistics
- Computer Science
- Machine Learning & Artificial Intelligence
- Information Science.

Once you have identified an issue, you need to decide how you are going to solve it.

Below are the broad steps that need some thought:

- 1. Specify the problem
- 2. Deciding on the research needed for a solution
- 3. Collect the data:
  - a. Identify the audience
  - b. Run qualitative analysis (focus groups, depth interviews)
  - c. Construct a questionnaire
  - d. Fieldwork (getting questionnaires completed by the target audience)
  - e. Ensuring data is in a form you can run qualitative analysis on (i.e. in digital format)
- 4. Run the analysis
- 5. Interpret the results
- 6. Communicate the results to the stakeholders
- 7. Make a plan, communicating this to your teams
- 8. Implement the solution to your problem
- 9. Monitor, review the results of your plan
- 10. Assess and refine your thoughts to see how you can improve things further. Then start again at point 1 changing the problem based on the evidence you have obtained.

I will be writing a series of articles covering the data science subject areas (points 1-5). I will do this from a conceptual point of view and try to keep the complexity of the mathematics to a minimum.

1. Specifying the problem

Phase 1 is the most critical phase as Albert Einstein said:

"The formulation of a problem is often more essential than its solution, which may be merely a matter of mathematical or experimental skill."

If you don't get this correct, you could be wasting money and resources, implementing a poor solution as the problem was not specified correctly. Consult with all stakeholders to get an understanding of the problem. Try to identify what result you are trying to achieve.

Assess the impact of resolving the issues and the benefits that would derive from the solution. Determine a budget to resolve the issue and what the potential cost savings/benefits the solution may have. Assess the value for money of the implementation would bring budgeted costs vs cost savings. If the budget allows, bring in professional help. If it is not value for money and you can work with the existing deficiencies, it may well be better not to embark on the project. Try to identify any issue and risks that the project may cause and try to mitigate these when specifying the problem.

2. Deciding on the research needed for a solution

You need to decide how you are going to solve the problem.

- What data are you going to collect
- What information you need to collect that will give you the answers you need
- From where and who do you need to collect data
- Decide what methods of data collection you are going to use
- Decide how you are going to analyse the data
- Decide who is going to interpret the results and then action them
- How are you going to communicate the results to the stakeholders?
- How do you assess whether the plan has worked or not?

3. Collecting the data

a. Identify the audience

Specify who your audience is, do you have access to every member of that audience? Ideally, you should. Everyone in the audience is called the population.

Try to identify any holes in the audience and see if you can reduce those holes, perhaps see if there are others with whom you can partner. Ensure that the audience has given their permission to be contacted so that you are GDPR-compliant.

If you ask every member in the audience and they reply it is called a census.

If you take a subset of the audience from the population, it is called a sample. The larger the sample, the more accurate the results are. However, depending on the specific case, a sample of 500 is usually good enough. Every person in the population should have an equal chance of being picked (this is known as the uniform probability model). If they don't have an equal chance, then bias can be introduced. Any bias can distort the results.

b. Run qualitative analysis

Often this an important phase.

Depth interview

Asks a lot of why questions to understand the topic areas providing descriptive data about people's behaviours, attitudes and perceptions, helps to understand complex processes, from this it will help you construct relevant questions in a questionnaire.

Focus Groups

A focus group discussion is an interaction among one or more experts and more than one individual. The intention is to gather data. In a focus group, discussion investigators interview people with common qualities or experience for eliciting ideas, thoughts and perceptions about subject areas or certain issues associated with an area of interest. It is particularly useful in segmentation studies as, when the participants take different views on a topic, there is a possible segmentation to be had. If the topic has consensus, then the topic is not discriminating and should not be asked in a survey that's aim is to segment the population.

Next time I will cover the other elements of "collect the data".

PAL stats
Bringing insight into focus for better decisions

Chris Cook
Managing Director
PAL Stats Ltd
Tel: +44 (0)1908 921 000
info@palstats.co.uk
https://palstats.co.uk/about-us/

visionist
digitally transformed™

Digitally Transformed™

At Visionist we know that your Digital Transformation investments must deliver substantial realisable benefits.

Our approach to digital transformation has allowed the department to realise the invest to save benefits of replacing their expensive legacy IT infrastructure with a Digitally Transformed IT service.

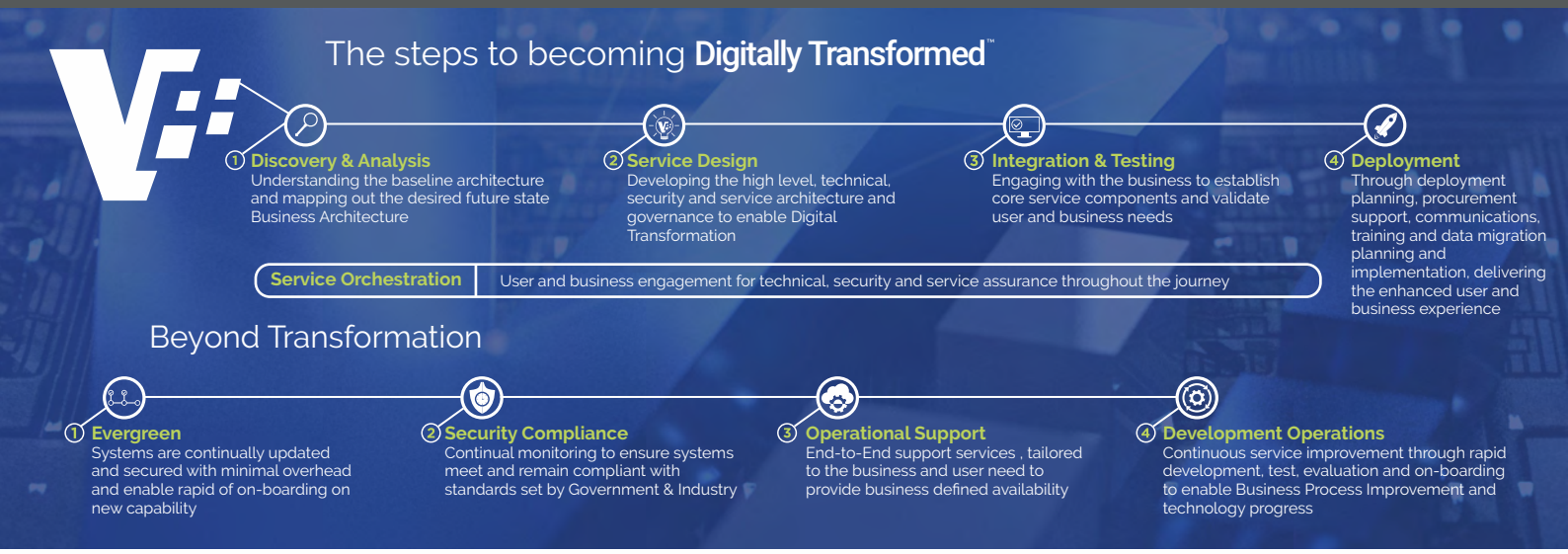
This has enabled the department to migrate from legacy PSN services to cloud based commodity services, within 6 months, enabling true business transformation opportunities.

But technology is not enough on its own.

Our passionate and energised enthusiasts have proven methods with demonstrable experience in delivery of tangible outcomes based transformation, in highly complex public sector environments.

To digitally transform your organisation let's talk
T: +44 (0)20 3883 8201
W: www.visionist.com

t: +44 (0)20 3883 8201
e: info@visionist.com
w: www.visionist.com



Digital Transformation in action

The Challenge

The Department needed to ensure minimal business disruption whilst ensuring that the disparate legacy systems and local "solutions" that had become the mainstay of Departmental Business would not hamper the desire to create a Digitally TransformedTM organisation. In addition, the Department had key Information Services delivered and hosted on the Public Services Network (PSN) where the Network itself was a secured "Official" environment.

Visionist were able to grasp the scale, scope and complexity of the challenges the Department faced, and deployed its resources, to support the IT Department as they led their community through change at pace, in an organised and prioritised fashion.

The Solution

Initially, Visionist designed the road-maps through acceptance, technical debt, inherited backlog and beyond. Thereafter, we embedded high performing agile teams, working in collaboration with Civil-Servants to ensure effective skills and knowledge transfer, helping them transition from using out-dated technologies and methodologies to a future-proofed department, using an aggregation of loosely coupled Cloud Technologies and an agreed Reference Architecture.

Our implementation of a demand management process via a prioritised pipeline, coupled with a strong customer focused Service Management function ensured that IT resources worked on activities that maximised business impact. Our strategy and technical-innovation enabled the Department to move its operational, data and digital-streams to cloud-hosted solutions, reducing legacy services and the reliance on disparate data centres and internal infrastructure.

Our ability to choose the right technologies to cut complexity and add agility, enabled the use of core services such as identity management and web security, which could readily be hosted on Amazon Web Services (AWS) and Microsoft Azure, utilising a model that secures the endpoints rather than the bearer network, in order to maintain and comply with security protocols. This strategy enabled the department to migrate at pace to Office 365

The Department's reliance on PSN applications was recognised and had the potential to be a barrier to the transformation. Our highly skilled technicians and architects innovated to develop a solution which provided PSN access via a standard Internet secured connection (accredited for OFFICIAL). This innovative "Reach-Back" solution enabled the Department to migrate from its legacy services to a new cloud-based service in their required timelines, with the ability to access PSN-hosted applications, whilst maintaining security governance and protocols.

Throughout, Visionist produced transition strategies based on an agreed reference architecture. To further ensure all systems decisions were in-line with Business Need and overseen by a newly instated Technical Design Authority, ensuring architectural consistency and re-use. This enabled our technical architects to make informed system decisions covering all areas of the transformation.

The Benefits

Utilising incremental prioritised deliverables, we were able to focus on high value business needs, enabling the successful delivery of 14000+ end-user-devices, enabling major cultural and behavioural change, significantly reducing outdated technology whilst transforming the data and information solutions available to all staff. In summary Visionist has enabled the Department to:

- Manage all devices effectively with a high degree of security assurance
- Use modern collaborative ways of working
- Implement a mobile first unified communications strategy
- Utilise a seamless reach-back to PSN Legacy applications
- Improve service performance
- Increase user satisfaction
- Exploit Evergreen technology with iterative improvements
- Enable cultural and behavioral change
- Create a Dev Ops capability to incrementally implement Business Process Improvements

The Outcome

We have enabled the Department to move its operational, data and digital streams to cloud-hosted solutions, reducing legacy services and the reliance on disparate data-centres and internal infrastructure/servers.

The re-use and simplification have allowed more agility and speed around delivery as well as the following savings:

- Retired PSN circuits -£440k per annum
- Third-party PSN hosting for PSN Apps - £50k per annum
- FCOS Hosting and Decommissioning - £1M per annum
- Move to Unified Communication and the Augmentation of Contracts £1.25M per annum
- Internal support of solution and removal of SI requirement circa £5m per annum

In conclusion our Reference Architecture and associated Roadmaps ensured applications and data were migrated with little or no down-time, there-after greatly improving the customer experience, e.g. failed logon attempts down by 15-20%.

Furthermore, our expertise has enabled us to architect highly scalable and re-usable solutions which could be used across government to improve user experiences and dramatically reduce costs.

Agile working is key to work-life balance and business profitability

Shella Snehi, a specialist employment lawyer at Excello Law, argues that agile working is key to work-life balance and business profitability

Agile working has become a new mantra for every employer over the past decade, not least since flexible working, was cemented in legislation such that every employee in the UK now has the statutory right to request flexible working after 26 weeks of employment. Requests to work flexibly need to be in writing and employers must have a sound business reason for rejecting them. Moving forward, according to conservative MP Helen Whately, flexible working should be the default position for all employees, rather than it being up to individuals to request it as she laid new plans before Parliament earlier this year.

The Government Flexible Working Taskforce has also expressed its commitment to promoting wider understanding and implementation of inclusive flexible work and working practices. But despite this dramatic shift in working culture, reinforced by a change in the law and Government manifestos, questions remain as to how far and how soon agile working will follow suit.

The death of the traditional office has been much discussed. Maintenance and upkeep costs are certainly significant. Scan the horizons of Britain's largest cities, however, and you can see many new offices are still being built. In the City of London, for example, several million square feet of commercial office space are currently under construction, with several million more planned over the next five years.

Some explanation comes from a report by Jones Lang Lasalle (JLL), which predicts that flexible working spaces are set to grow by up to 30% annually for the next five years, changing how businesses of every size organise their workforce. Last year, flexible workspace operators took up one-sixth of all new commercial property in London while their footprint grew fastest in Manchester and Birmingham. Firms like WeWork and IWG provide office space, enabling clients to vary the number of desks and how long they need them for. This, in turn, serves as a boost to agile working.

But much of that impact still lies in the future, not the present. For now, company offices are still the norm, not the exception, but companies can still apply an agile working mentality by thinking of their employees' work in terms of performance and outcome as opposed to hours spent in the office. Technology, of course, is key – the fuel which allows much agile working to happen. When applied to computers, it enables employees to work wherever and whenever they choose.

> "...tech-enabled agile working is no longer a new phenomenon: millions of workers now use computers and smart devices outside the office as part of their work."

Productivity is a much wider issue in the British economy as it lags stubbornly behind many of its European neighbours. Some research suggests that flexible workers work more productively than their fixed hours counterparts. A study by HSBC found that the professional services industry is the most likely to offer employees flexibility, with 36% of professional services employees saying it is available to them and that 89% of employees believe flexible working is a key motivator to their workplace productivity levels, more than financial incentives. By allowing employees to work flexibly and applying the "working smart" philosophy that applies to agile working, businesses can both save money and boost employee effectiveness and productivity.

Businesses which deploy agile working structures can be the key to employees being able to work how and when they want and still be able to ensure excellent client service. Every survey suggests that employees like

Shella Snehi, a specialist employment lawyer at Excello Law

the freedom which it provides. Agile working can lead to lower absenteeism and greater employee loyalty. Innovative working practices, therefore, result in a win-win situation for both businesses and their employees. Companies may otherwise be losing out on talented and valuable employees if they do not provide the flexibility desired. Encouraging and supporting a flexible approach not only support a healthy work-life balance but also contributes to business success and growth.

Of course, tech-enabled agile working is no longer a new phenomenon: millions of workers now use computers and smart devices outside the office as part of their work. But predicting how future technology might enable businesses to improve employee engagement is hard, particularly since the evolution of artificial intelligence (AI) is set to change the world of work in a myriad of ways.

How such technology will facilitate evolving working patterns, therefore, remains to be seen, although forecasts suggest that the convergence of AI systems with the agile world is set to have a significant disruptive impact in the next decade. As agile working continues to become more prevalent across both the private and public sectors, it will undoubtedly continue to play an important part in meeting the aim of working better and more efficiently, not longer and allowing for greater work-life balance.

It remains to be seen if the traditional 9-5 model will be declared 'dead' as flexible offices and agile working continues to rise. For some, agile working already brings a world of exciting opportunities for working in a way that personally suits and from any location – all that is needed is a laptop and a reliable internet connection. ■

Shella Snehi
Employment Lawyer
Excello Law
Tel: +44 (0)845 257 9449
ssnehi@excellolaw.co.uk
www.excellolaw.co.uk
www.twitter.com/ExcelloLaw

Agile awareness: Creating an essential baseline

Creating more agile organisations requires a level playing field of agile knowledge for all employees. What can the public sector gain from new approaches in higher education? Kim Whitmore from the Agile Business Consortium explains more

When it comes to training for #GenerationAgile and beyond, the pace of change and the need for adaptability and innovation have made agile working and business agility essential skills for all aspects of business and commercial life. However, most professional agile accreditations are designed for practitioners already in the workplace, working in agile teams.

A short course and qualification were needed to offer agile beginners an overview of agile principles and practices; one that would improve their employability and act as a foundation for further career development.

Early education in agile knowledge and skills is the objective of the Agile Business Consortium's campaign for Generation Agile. Offering agile training to students through University-based programmes is an effective way to deliver valuable knowledge before young people enter the workplace. However, the same training and approach are also suitable for those already in work who have little agile knowledge – whatever stage of career they're in.

The academia/workplace divide

"Today's workplace is highly competitive," states Dr Islam Choudhury, Associate Professor at Kingston University and Director of the Agile Business Consortium. "Kingston University has worked with the Agile Business Consortium to design this new programme to give students and professionals the understanding and vocabulary they need to talk confidently about agility and demonstrate that they have the mindset and attitude to create success in the workplace.

"It's valuable to have short, focused training to introduce agile as practised in industry. Agile Practices provides this as a standalone certification course where attendees engage in interactive teaching sessions and workshops. This increases their knowledge, understanding, authority and credibility with various agile approaches.

"Agile is gaining increasing traction in public and private sectors alike", Islam affirms, "The education system must prepare people to be effective in the workplace and deliver the skills that industry needs and the marketplace demands. This Agile Practices course is an important step towards closing the gap between education and industry.

"The course content for this certification can be delivered in a variety of ways – it is itself very agile. It can be absorbed into scheduled teaching time and spread over a semester for those in education, or it can be taught in a couple of fast-track intensive days. Each university or organisation can decide what works best within their teaching/learning and development system."

> "Our experience with the Agile Practices certification is that attendees value the broad learning it offers. It also helps that the exam mimics the format of other professional exams, so attendees are well prepared for further study in the workplace."

Kingston and Westminster universities leading the way

The Agile Practices certification now sits alongside AgilePM® as part of the learning portfolio developed at the Agile Business Consortium and over 500 students have now achieved the Agile Practices Foundation Certificate through Kingston and Westminster universities, with an average pass rate of over 80%.

Islam continues, "I believe that Agile Practices equips the agilists of tomorrow to think outside the box and build for themselves a practical and effective agile toolkit. It also offers a broad base from which to move forward to study other agile certifications and a practical baseline of knowledge for organisations to utilise."

Dr Nadia Amin is Principal Lecturer in Information Management at Westminster Business School. She introduced the Agile Practices exam for the first time in 2018. "Agility is now a mainstream business skill and we are

making our agile project module compulsory from 2020. We believe that supporting students to gain a good understanding of business agility and agile methods will improve their employability. We need to equip people not only to understand different agile frameworks but to be able to develop further to create hybrid methods and solutions in practice.

"Our experience with the Agile Practices certification is that attendees value the broad learning it offers. It also helps that the exam mimics the format of other professional exams, so attendees are well prepared for further study in the workplace.

Agility for all sectors

"Businesses and public sector organisations in the future will have a growing need to be agile", Islam affirms. "This course provides a life skill that will be valuable for students of all disciplines. My students that have moved into roles as wide-ranging as teaching or marketing have told me how useful this grounding in agile has been for them.

"Agile Practices offers a way to move forward when your workload feels overwhelming. When change is rapid, we need constant adaptation, incremental progress and to benefit from transparency and the drive for continual improvement. We need to be able to stand back and review what we have done objectively, to accept feedback and move forward to make our results even stronger.

"In today's world, we simply cannot do everything in one go. Agile Practices helps students and employees to see change as a benefit, rather than a whirlwind of loss."

Between the main agile approaches of XP, AgilePM, Scrum, Kanban and SAFe, the terminology alone is confusing. Gaining an understanding of these concepts is essential in an increasingly agile working world.

Availability in the workplace

Following successful delivery at Kingston and Westminster Universities, Agile Practices is now available for delivery by training organisations and learning and development departments by agreement with Agile Business Consortium and is being very positively received.

> "It's valuable to have short, focused training to introduce agile as practised in industry. Agile Practices provides this as a standalone certification course where attendees engage in interactive teaching sessions and workshops. This increases their knowledge, understanding, authority and credibility with various agile approaches."

In fitting with the Consortium's mission to lead, support and enable business agility worldwide, the financial barrier to entry is low, with Consortium members being charged just £60 for the exam. Non-members pay £75.

If you are interested in taking Agile Practices or offering it through your organisation, you can find out more at agilebusiness.org/agilepractices

Agile Business Consortium

Kim Whitmore
Head of Product
Agile Business Consortium
Tel: +44 (0)1233 224 333
kim@agilebusiness.org
www.agilebusiness.org
www.twitter.com/Agile_Biz

Health and social care network – a vision or reality?

Mike Thomas, Managing Director of Innopsis, the trade association for suppliers of digital infrastructure and services to the UK public sector asks if a health and social care network is a vision or reality

The recently issued Internet First; Policy and Guidance from NHS-Digital has been interpreted that the Health and Social Care Network (HSCN) is a temporary transition network residing in time between the N3 network and the Internet.

The N3 network existed for 16 years supplied by a single organisation. At the end of the contract, a transition arrangement was put into place allowing NHS users to transition to the Health and Social Care Network (HSCN). This transition is still undergoing, with the first wave of connections starting at the end of 2018, following competitive procurements. During 2019, the majority of the N3 connections will be replaced by HSCN connections. The aim is that by 2020, all connections will be on HSCN rather than N3. This activity sets the foundation going forward.

One interpretation is that the recent policy paper means the 34,000 HSCN connections will be now replaced by internet connections? Has the procurements and investments by industry and consumers alike been a waste of time? No, but it does raise some interesting points that users and suppliers should consider.

In simple terms, what is the difference between HSCN and the Internet?

Firstly, we should take note that HSCN includes internet access. Indeed, HSCN does not state whether a private connection or internet connection is used to deliver services.

The ubiquitous access offered by the Internet is particularly attractive to a more mobile workforce. As patients increasingly adopt Full Fibre connectivity and with the dawn of 5G connectivity around the corner, it is likely that in five to six years' time, health workers will have reliable remote connectivity to enable access to patient records and much more. This will reduce the time taken to update and file reports. It potentially will allow more data to be shared with more agency workers.

Similarly, the movement of private servers to the public cloud providers such as Amazon, Microsoft and Google will hasten the adoption. We have seen a number of international healthcare application providers viewing the opportunity that the open HSCN market provides. The cost of porting an existing service into a UK instance of AWS or Azure and delivering to NHS users is almost negligible. The result will be cheaper and faster services using the latest technology.

When it comes to the choice to use a public internet or a private network connection, the answer depends on the business criticality of the connection. Whilst a private connection appears to be the same as a public internet connection, there is a big difference behind the scenes. The infrastructure is much the same, but it is in how the data is monitored and routed that the differences arise. A private connection (IPVPN or SD-WAN) it can be likened to a 'Bus only' lane in a city. The private connection has a dedicated routing through networks to ensure that bottlenecks are avoided, traffic is delivered and the routing is known and monitored. Just like a bus lane where the segregation of the bus traffic means that buses have a greater chance of keeping to the timetable, road sensors provide progress updates which means that bus stops are not missed and journeys are not held up.

The Internet is more like a public road. The traffic can be held up or slowed depending on the volume of traffic, the shortest route may not be taken and detours and re-routing are common. Journey times can be a rough estimate rather than fixed. The time of day can impact driving time significantly and it is likely that you don't know where someone is on the journey.

Mike Thomas, Managing Director of Innopsis

Given the clear benefit of reliable network connections in pre-emptive healthcare scenarios (e.g. wearables for medical use) and the increasing move towards centralised cloud services, the understanding of the difference between a congested internet connection and a network service with guaranteed SLAs is crucial to the success of the digital vision. This vision is also supported by both the guidance from the NCSC and the GDS, where the needs of the application service are paramount in determining the assurances required.

In relation to interpretations on the NHS policy paper, we need to understand the context of time. To fully migrate into an 'Internet Only' world, this would rely on all relevant applications being available on the Internet. The National Centre for Cyber Security (NCSC) suggests that an internet connection is an acceptable option, provided that the service is treated as untrusted and that additional security should be deployed to protect the data in transit.

Currently, the vast majority of applications that NHS workers would need to access are not internet-enabled and do not have the application security recommended by NCSC yet. Indeed, the estimate is that it could be well over seven years before those applications meet the standards published or are replaced. Whilst there are pockets of NHS workers where this will be achievable much sooner as new applications are being deployed, there will need to be a greater focus and investment to bring this gestation period shorter. Therefore, HSCN will remain as the prime choice for NHS consumers for some time.

It is also important that we need to consider the cost. The recent round of procurements were benchmarked against standard Internet connections. The HSCN connections were around 5% to 10% cheaper. Savings will typically be made within the applications and more efficient work practices rather than the connectivity.

The focus for NHS-Digital should be enabling public facing, internet- delivered, front ends to their current applications, where appropriate. This will help realise the Secretary of State's vision of an internet- based Health Service, complementing not replacing HSCN. ■

Mike Thomas
Managing Director
Innopsis
Tel: +44 (0)800 997 8805
info@innopsis.org
www.innopsis.org
www.twitter.com/InnopsisUK

Public sector: Recovering from austerity

Neville Henderson, Senior Consultant, Crown Workforce Management discusses how the public sector can recover from the pain of austerity in this article

Prime Minister Boris Johnson may have pledged a cash injection for some public services – a reputed £1.8 billion for NHS hospitals and a further 20,000 bobbies on the beat – but the wounds of deep austerity cuts will take many years to heal.

Whatever your political persuasion, whatever the rights and wrongs, the 2010 austerity programme embarked upon in response to the 2008 financial crisis by the coalition government, gathered momentum and led to unparalleled change within public services.

The infamous note left by the outgoing Chief Secretary to the Treasury, Liam Byrne, for the new incumbents which read: "I'm afraid there is no money" was a postscript to a situation which prompted central and local government to find ever-more inventive ways of saving cash.

With human resources being a significant overhead, it is perhaps not surprising that the axe was the first to fall there. But at what cost? Local authorities have been pushed into becoming the facilitators of services rather than the delivery.

With the loss of experienced employees, skills and local knowledge ebbs away, along with the quality of service, squeezed by demands for lower costs, often questionable employment practices (poor wages/conditions, zero hours contracts etc.) and contrary to the philosophy of those contracting out the services.

Those put forward the argument for outsourced services believe that they open up competition and that the private sector is more likely to achieve efficiency improvements, is more innovative, less hierarchical and more focussed, leading to improved value for money.

In doing so, the core workforce is reduced to a lower level which is initially viewed as win-win, less cost and guaranteed assured service levels but it all too often lead to a lack of engagement in the workforce with poor motivation and a "them and us" culture. Failures have been seen over the past few years in G4S and Serco to name just two.

As the public sector begins to claw its way up from the austerity precipice, it may wish to consider an alternative solution that enables it to do more with its core workforce by managing it in a demand-responsive way.

Underinvesting in the workforce, can result in an organisation becoming more expensive not less so. It is by no means easy but by following these steps can cut costs while maintaining services.

Plan work patterns using as much information as is available

Work with employees, representatives and unions to engage the correct number of people in any shift pattern taking account of absence sickness and holidays. Analysis may even show,

irrespective of other benefits of reducing excessive working hours, that this may even be a cheaper option especially where higher overtime rates are prevalent or external support is costly.

Understand any reasons for absence and whether you are able to actually address them not just fill them. When do they occur, who is absent, what issues are caused by the absence e.g. could multiskilling prevent additional hours requirement. Is absence repeated by specific individuals, for what reasons – they may or may not be genuine? Does it occur at specific times such as around time planned off?

Ensure that holiday time is taken in to account, if holiday is taken evenly then with average holiday entitlements an additional person is required for approximately every nine employees. However, holiday is not normally taken evenly! Is there anything that can be done to ensure that this is planned to fit not only with workforce requirements in mind but also those of the business e.g. a blanket rule of a number of people allowed off may not be suitable if there is a period of slack – encouraging employees to take time off when the business doesn't need them or service level is lower may at times help both parties.

Matching short term peaks and troughs through better shift planning

Analyse requirements to see if there are different needs for people to be at work at different times then try and plan for them. A simple example may be where you currently have five, eight-hour shifts, Monday to Friday. However, Monday, for this example, was generally the busiest day of the week, often required extended working through overtime, with a lighter requirement the rest of the week. The response should be to build a shift pattern with a 10-hour Monday reciprocally seven-and-a-hour shifts the rest of the week. It may be that it is possible to increase the hourly rate slightly to offset any employee losses from this overtime reduction – in reality all then become winners as the employee is at work fewer hours and the business may well maintain a better productivity level, although this wage increase may be only aspirational. This type of system is frequently seen in accounting where month-end weeks have longer shifts than other weeks.

Matching longer term peaks and troughs using banked hours schemes

There are a multitude of working arrangements that range from flexitime to annualised hours that rely on banks of hours to allow different shift lengths to be worked in different periods of the year, month or day. Flexitime is generally seen as a form of working aimed more towards helping employee flexibility but with care schemes can be designed to work with matching business demands as well. The best schemes will help both. An Annualised hours scheme is in essence a banked hours scheme based on a year. They often go slightly further than simple banked hours as other entities such as holidays and pay are also based on a year so all can be aligned

Managing banks and/or overtime levels ensuring evenness

Whichever form of flexibility is chosen or even if you stay with overtime then the problems can be reduced through maintaining a good record of hours worked by each individual. This would include monitoring all types of hours, normal hours and overtime/banks and ensuring that there is a good balance of hours – ideally across all relevant employees. Workforce Management Systems, such as that provided by Crown Workforce Management, ensures that planners are able to look at attendance demand and can rank employees based on a variety of criteria, such as cost (labour grade), attendance information, bank levels or overtime usage to ensure fairness whilst making sure that people are in the right place at the right time.

Whatever the future holds in store, one thing is certain: ours is a changed landscape. It is only by thoroughly understanding our organisations and the demands placed upon them can we affect change to similarly respond to those needs and deliver better service.

Download our free white paper on The Workforce Management Renaissance within the Public Sector.

For more information on Crown Workforce Management visit our website.

CROWN
Inspired Workforce Management®

David Hughes
Head of Marketing
Crown Workforce Management
Tel: +44 (0)1827 309800
dhug@crowncomputing.co.uk
www.crownworkforcemanagement.com
www.twitter.com/CrownComputing

Effective response and mitigation of advanced cyber-attacks via an intelligent cyber-defence framework

Dr Nicholas Kolokotronis from the University of Peloponnese and Dr Stavros Shiaeles, School of Computing, Faculty of Technology at the University of Portsmouth, impart their expert thoughts on effective response and mitigation of advanced cyber-attacks via an intelligent cyber–defence framework.
Both authors have received funding from the EU's Horizon 2020, under grant agreement 786698

Cyber–threat intelligence (CTI) refers to the process of gathering and organising information that can help organisations identify, assess, monitor and respond to cyber–threats. A detection and mitigation platform that exploits the available CTI is crucial for tackling the grand challenges inherent in securing the ecosystem of the Internet of Things (IoT) devices. Such challenges rest with the structure of typical IoT networks that are comprised of heterogeneous connected devices whose flawed design allows the cyber–attackers to easily compromise them and form enormous IoT botnets[1]. Effective response and mitigation of sophisticated cyber-attacks are crucial and a systematic approach to model attack strategies needs to be developed so as to properly identify the possible weaknesses of a system, the relevant security risks in relation with the possibility of an attack being successful, as well as the countermeasures required for addressing these security issues, both proactively and reactively. This is a non–trivial task, taking into account the inherent complexity of IoT ecosystems, as well as the fact that new vulnerabilities – and thus relevant security risks – are constantly arising.

CTI tools are responsible for the efficient collection of information regarding emerging cyber–threats or possibly unknown vulnerabilities that are available from various sources and their ranking in terms of criteria like popularity and impact; the dissemination of CTI to the relevant cybersecurity controls is imperative for increasing an organisation's defensive capabilities. Typical solutions should address key security aspects[2,3] like:

- Efficient identification and crawling of sources with valuable cybersecurity information to retrieve relevant (and time–varying) content on vulnerabilities, exploits, products, etc.

> "Many tools exist for detecting open ports and vulnerabilities on a network's devices, but their limitation is that they identify vulnerabilities and plan any mitigation action on a per host basis; therefore, they are unable to detect sophisticated multi-stage attacks, which usually occur in highly complex and dynamic environments as in the case of IoT, by correlating such information."

- Accurate extraction of site-specific content from the retrieved data (filtering out irrelevant content) to obtain information on vulnerabilities, affected platforms, exploits used, etc.

- Efficient storage, indexing, etc. of gathered CTI and dissemination amongst the cybersecurity experts, to rate the quality of the CTI and increase awareness.

In addition, CTI may be used to augment the knowledge that intelligent cyber-defence controls have in order to efficiently detect and prevent attacks. Such security controls – typical examples of which include host–based malware detection systems[4] and network–based intrusion detection systems[5,6] – typically utilise sophisticated machine learning (ML) algorithms having incremental learning abilities. To this end, novel intrusion detection approaches have been proposed, relying on

properly designed convolutional neural networks (CNN), that convert data (e.g. software binaries of IP packets' payload) into 2D images to increase efficiency[6]; CNNs are particularly suited for the classification of images and can be easily retrained to learn quickly from updates to the neural network. Such methods may achieve high accuracy (more than 92%), which meets the accuracy needs for practical use, as well as high precision and recall (again more than 92%) showing the ability to differentiate malicious from benign data.

Intelligence may also come in the form of efficiently modelling the attack strategies and profiles that characterise the resources available to attackers (e.g. budget and tools) for exploiting vulnerabilities of any kind to attain their goals, such as privilege escalation, quality of service reduction, etc. Graphical cybersecurity models (GCSM) constitute important primitives for efficiently representing multi-stage attack strategies, thus, enhancing the capability of intrusion detection systems to respond to advanced cyber-attacks[7]. GCSMs need detailed information about software weaknesses, misconfigurations, network connectivity, firewall rules, etc., of the devices in a network in order to identify, via specialised algorithms, the possible attack paths a cyber–attacker might follow (possibly in an adaptive manner) towards achieving his goals and the associated impact. Many tools exist for detecting open ports and vulnerabilities on a network's devices, but their limitation is that they identify vulnerabilities and plan any mitigation action on a per host basis; therefore, they are unable to detect sophisticated multi-stage attacks, which usually occur in highly complex and dynamic environments as in the case of IoT, by correlating such information.

The combination of ML-based intrusion detection systems (IDS) and GCSMs can lead to an innovative class of intelligent intrusion response systems (iIRS) providing dynamic security risk assessment and intelligent mitigation strategies to defend against adaptive multi–stage cyber-attacks in an optimal and autonomous fashion[8]. This can be achieved by building upon advanced game–theoretic security approaches that, given a GCSM for the IoT network under consideration, accurately model the players (attackers and defenders) and their interactions. This model includes what each player knows about the network, what attacking and defending actions can be performed, what goal (and the associated reward) is to be attained,

etc. The key aspects that such solutions need to address include:

- The development of an ML-based IDS that can identify unknown (i.e. zero–day) attacks.
- Accurate modelling of cybersecurity aspects via game-theoretic frameworks and effective tackling of the complexity and efficiency issues arising in each case.
- Enhancement of defenders' capabilities against multi-stage attacks by incorporating GCSMs into game–theoretic models specifically for intrusion prevention and response.
- Development of algorithms for solving the formulated games, in a centralised or decentralised manner, to yield the optimal defender's response and minimise attackers' success.

By achieving the above results, the designed iIRS will prove to be valuable as part of solutions offering built–in resilience, which will help stakeholders to better protect their assets against advanced large–scale cyber-attacks. Thus, to generate a positive impact for small and medium–sized enterprises, but also for critical infrastructures and industrial IoT facilities, further research and development on the following aspects is required: methods for the detection and mitigation of (unknown) sophisticated cyber-attacks, solutions for the acquisition of actionable CTI, the development of intelligent defense methods and most importantly, innovative tools for embedding cybersecurity in future autonomous intelligent products. ■

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Dr Nicholas Kolokotronis
Department of Informatics and Telecommunications,
University of Peloponnese, Greece
Tel: +30 2710 372231
nkolok@uop.gr
www.uop.gr/~nkolok

Dr Stavros Shiaeles
School of Computing, Faculty of Technology
University of Portsmouth
Tel: +44 (0)2392 846 783
sshiaeles@ieee.org
www.shiaeles.net

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What was the first year of GDPR like? Where is it heading?

Ius Laboris share their thoughts on what the first year of GDPR looked like and where they see it heading in the future

In the run-up to 25 May 2018, preparations for the implementation of the European Union (EU) General Data Protection Regulation (GDPR) were a key priority for organisations. The GDPR's entry into force was viewed with concern, given its complexity, the challenges of putting the new data protection rules into practice and the extremely high fines that can be imposed for breaches. The majority of infringements can be punished by a fine of up to €20 million or 4% of an organisation's total worldwide annual turnover for the previous financial year (the higher of the two). Over a year on, with the first wave of decisions and fines issued by a number of national data protection authorities (DPAs) and many ongoing investigations, it is interesting to examine if and how the GDPR rules are actually having their desired effect.

Enforcement authorities in many countries have used this first year as a grace period to educate and promote compliance with the GDPR. Corporate awareness of the GDPR rules and potential repercussions of breaches has increased and new or enhanced data protection policies have been implemented as companies' ability to handle personal and sensitive data safely and in compliance with the data protection principles has been subjected to fresh scrutiny. These include a significant increase in the employment of Data Protection Officers (DPO). If a DPO is appointed (which is not always mandatory), it is the DPO's responsibility to inform and advise with respect to data protection obligations, to supervise compliance with these obligations and to cooperate with the DPA(s).

As awareness has risen, there have been a growing number of complaints and breach notifications across the EU. DPAs in some Western European countries such as Germany and France appear to have been very proactive in enforcement. For example, the French Data Protection Authority ('CNIL') imposed a €50 million GDPR fine on Google LLC in January 2019. The huge fine was based on a lack of information and transparency for users and took into consideration the large volume of data and number of individuals involved in this violation of privacy.

> "The GDPR has faced some criticism, with commentators noting that the law in its current state is broadly worded, meaning the regulations are open to differing interpretation. This means there is a risk of divergent decisions in different jurisdictions when investigations are carried out."

The UK's Information Commissioner's Office (ICO) also recently announced its intention to impose large fines on Marriot and British Airways, as a result of data breach-related incidents. The proposed fines announced were £99.2 million for Marriot and £183.4 million for British Airways, highlighting the seriousness with which the ICO treats such cases.

Others, however, have been slower to take significant enforcement action and in Eastern Europe, many countries have taken a mild approach to enforcement. While the Polish and Lithuanian DPAs have imposed relatively significant fines, Latvia, the Czech Republic and Hungary have only imposed very minor penalties. At the time of writing, the Slovak DPA has only fined organisations for failing to comply with inspections and not for GDPR breaches and the Bulgarian DPA has mainly issued warnings and reprimands. Slovenia is one of the EU Member States that has not yet completed the process of implementing the GDPR into national legislation. Warnings have been issued in a number of jurisdictions and the various DPAs are making orders for bringing processing activities into compliance; there should be further activity over the coming year.

The GDPR has faced some criticism, with commentators noting that the law in its current state is broadly worded, meaning the regulations are open to differing interpretation. This means there is a risk of divergent decisions in different jurisdictions when investigations are carried out.

Further, given that GDPR is an EU Regulation, its validity in the UK will come into question following Brexit. Most experts believe that the GDPR will be enacted in UK Law after Brexit under section 3 of the European Union (Withdrawal) Act 2018.

In light of recent high-profile cases, however and with more predicted imminently, global businesses now have a better insight into the financial and reputational repercussions of failure to comply with data protection principles. The trend towards stricter data protection rules is likely to intensify, as the value placed on an individual's data privacy continues to rise. It is clear that compliance is key to avoid very significant penalties and organisations and individuals should continue to invest in education and training and promote compliance and best practice.

This article is based on information contained in a comprehensive report 'The GDPR: One Year On' prepared by Ius Laboris in May 2019. Further information on how the GDPR has been enforced across various European jurisdictions in the year following its entry into force can be found in the full report, here. ■

Ius Laboris
Tel: +32 2 895 4521
info@iuslaboris.com
www.iuslaboris.com/en-gb/
www.twitter.com/iuslaboris

Perspectives on Information Governance

Cardiff Council's Operational Manager, Information Governance and Risk, Vivienne Pearson and Information Governance Manager, Dave Parsons, set out the vision and benefits their training offers

At a time when Information Governance practitioners are at a premium, we all need to play our part in understanding our personal and our organisation's responsibilities and help to build capacity so that data and privacy matters become second nature. Information Governance is not a tick box exercise and often there is no right and wrong answer, it is a judgement call.

IG Solutions, Cardiff Council's Information Governance training service, was established in order to share our extensive knowledge and expertise of Data Protection and Information Governance with public service partners across the country.

IG Solutions delivers practical training designed to help organisations overcome the challenges they face and understand their responsibilities to manage the strategic risks of fines and reputational damage.

Our training is focused on Data Protection, Freedom of Information and Records Management and we are able to tailor courses to meet your specific needs.

Our vision

Our training is designed to help you understand how compliance can be achieved based on our knowledge, experience and best practice approaches adopted across the public sector, including frameworks such as the Wales Accord for Sharing Personal Information (WASPI), which we hope will help facilitate increased use of consistent methods of controls and assurance.

Busting the myths that:

- The law is new and we have never considered the privacy of individuals.
- The public sector is resistant to change and not good at managing risk.

The introduction of the General Data Protection Regulation (GDPR) and Data Protection Act 2018 arrived with the bluster of being 'the new kid on the block.' We explore how the challenges around data protection have grown and how they work to protect the rights of individuals developed and that many of the changes introduced in 2018 were enhancements to existing laws and best practice.

Public services have always been resilient and are often the leaders in the areas of change and risk management. We explore our journey and experience of making significant changes to our processes as a result of focussing on the increased enforcement powers of the Information Commissioners' Office in 2012; the plethora of Codes of Practice issued over the past 10 years; keeping up-to-date with the developing GDPR legislation; taking the decision to anticipate some of the changes whilst looking to secure traction for actively managing the Council's risks around data protection; and information governance more widely.

We hope that our training helps you to tackle these myths and consider the practical application of the key areas of organisational and technical control as part of your approach to managing risk.

Building capacity and control

Good working arrangements across Wales are already in place with collaborative and regional working amongst Information Governance Managers and Data Protection Officers. However, with increasing demand for regional collaboration and alternative service delivery models across the public service, we need to ensure that there is improved awareness and understanding of information governance to support the drive for change. We have built our training on the experience we have in supporting Cardiff Council and collaboration models, such as Rent Smart Wales, the National Adoption Service, Vale Valleys and Cardiff Regional Adoption Service and Shared Regulatory Services. Our training and educational support will help you to increase the 'information governance' capacity within your organisation, enable you to share the 'information

"The introduction of GDPR has had an impact in the way professional organisations compile and use information. This can at times appear daunting, not helped by a range of myths around this area. I have found the approach and advice of the service to be both professional and supportive. When required, time was taken to give balanced advice on key areas and reassurance given as to how we were sharing information. This gave confidence in how to approach sensitive issues".
Adrian Dinsmore, Headteacher, Hawthorn Primary School

governance' responsibility across your employees and help you to identify the risks and controls around the use, and sharing of personal data.

Developing a risk-based approach to Information Governance

Public services will continue to face increased scrutiny by the Information Commissioner in the coming months and years. Much of the focus of the Information Commissioners' enforcement powers has been on large-scale privacy infringements. Recent publicity around the intent to fine several large organisations is a testimony to this. It is vital that the public sector does not become entrenched in an attitude of 'this will never happen to us' and the perception that 'it is not in the interests of the Commissioner to fine the public service.'

A large-scale data breach has the potential to damage public service in more ways than one. Not only would a financial penalty have potential consequences on your frontline service provision, but would also bring about irreparable damage to your organisation's reputation and standing.

Our training is designed to help organisations focus on the key controls and assurance that they need to prioritise enabling you to demonstrate that due diligence is in place to protect personal data in the event of a data security incident.

Raising awareness and supporting a culture of responsibility

The importance of education and training cannot be understated as part of any ICO investigation one of the first questions they ask is for evidence of the training you have provided for your employees.

Our approach enables you and your organisation to have a fresh, independent, insight to the world of compliance with data protection, as well as providing a range of tools and skills for you to consider taking forward within your organisation. Ultimately, we are all in this together.

Information Governance is not just the domain of subject experts it is everybody's responsibility.

Bob's Business
Cyber Security Awareness Training

the maltings
document storage solutions

RICOH
imagine. change.

SOLUTIONS

Vivienne Pearson
Operational Manager, Information Governance and Risk
vpearson@cardiff.gov.uk

Dave Parsons
Information Governance Manager
dparsons@cardiff.gov.uk
Cardiff Council
www.infogovernancesolutions.co.uk
www.twitter.com/IGSolutionsCC

The government's relationship with commercial suppliers: A focus on prompt payments

Simon Hart MP, Minister for Implementation at the Cabinet Office in the UK, underlines an aspect of his brief that concerns managing the government's relationship with our commercial suppliers, with a focus on the importance of prompt payments

The first task for anyone starting a new job is to get to grips with their in-tray. As Minister for Implementation, I have got a broad brief: as well as the government's digital service, property portfolio and cyber resilience work, a core part of my job will be managing the government's relationship with our commercial suppliers.

> "Prompt payment is an issue at the heart of the supply chain, and of crucial importance to the small businesses that form the backbone of our economy. Failure on behalf of government outsourcers to pay settled invoices promptly can threaten the very existence of their smaller suppliers and cause sectors of the economy to stagnate."

And a key element of that is the new prompt payment rules we have brought into force at the start of September. They demand that government outsourcing partners pay 95% of all their invoices within 60 days or risk missing out on major government contracts.

Prompt payment is an issue at the heart of the supply chain, and of crucial importance to the small businesses that form the backbone of our economy. Failure on behalf of government outsourcers to pay settled invoices promptly can threaten the very existence of their smaller suppliers and cause sectors of the economy to stagnate.

I am confident we've implemented a workable and pragmatic solution to this decades-old issue. The new rules are a vehicle for behavioural change and a shift in payment culture which will produce long-term results. Rather than impose punitive measures that will do little to improve the delivery of public services, we will work with outsourcing partners to try and get them where they need to be.

Simon Hart MP, Minister for Implementation at the Cabinet Office

Outsourcers deliver vital public services, savings for the public purse, create opportunities for smaller suppliers and are a consistent source of innovation. But we need to ensure the health of the whole supply chain and I am determined to look after the wellbeing of small businesses.

That's why we have clearly set out these new rules. It is now for our outsourcing partners to meet them. ■

Simon Hart MP
Minister for Implementation
Cabinet Office
Tel: +44 (0)20 7276 1234
publiccorrespondence@cabinetoffice.gov.uk
www.gov.uk/government/organisations/cabinet-office
www.twitter.com/cabinetofficeuk

Social value goes mainstream

Guy Battle, CEO OF Social Value Portal explains how social value has now gone mainstream, including how the Public Services (Social Value) Act has transformed the relationship between the public sector and its suppliers

We have come a long way since January 2013 when the Public Services (Social Value) Act was implemented and there is now clear evidence that the Act is not only transforming the relationship between the public sector and its suppliers but also that it is delivering real additional value for those organisations embedding it properly into how they are doing business.

Leading organisations are now delivering an additional +20% for every pound spent which for a typical council spending £100 million per year could be as much as an additional +£20 million for local communities.

However, councils can and should be doing more to help their suppliers deliver and it is disappointing that so few buyers make it easy to find social value policies and nor do they provide toolkits. A survey carried out by Social Value Portal to assess how easy it was to find and download guidance about social value on councils' websites found that barely 10% of councils have a social value policy available to suppliers and only 17% mention it in their procurement strategy leaving a staggering 73% who make no mention of social value on their website at all.

But the total opportunity is enormous and with a total local and central government spend of £188 billion per year, this could lead to an additional £36 billion of social value for our communities which is extended even further by an additional £15 billion if social value were to be embedded into planning; Surely a prize worth fighting for?

What is the Social Value Act?

Social Value refers to the wider financial and non-financial value created by an organisation through its day to day activities in terms of the wellbeing of individuals and communities, social capital created and the environment.

Social Value is defined through the Public Services (Social Value) Act 2012 (Act) which came into force in January 2013 and requires all public sector organisations (and their suppliers) to look beyond the financial cost of a contract and consider how the services they commission and procure might improve the economic, social and environmental well-being of an area.

As local authorities are becoming increasingly financially self-reliant and central government budgets are cut, they need to be looking at how to make their limited resources go even further while still maintaining the quality and breadth of services. Social value represents an area where additional community benefits can be derived and may be seen as a complementary activity to other strategies such as commercialisation.

What are the benefits?

The Act provides a significant opportunity for the public sector to engage with its supply chain by rewarding organisations that go beyond the provision of just the core contract requirements to deliver more value for the community. This can deliver solutions that are the most economically advantageous and will also, over the long-term, help to reduce cost and build a more resilient, healthy and economically strong community.

Key benefits can include:

- Better value for money delivering more for the public pound by requiring your suppliers to do more than 'just' deliver the core services.
- Increases local spend by rewarding organisations that are local or have a local supply chain, especially SMEs and VCSEs.
- Increases opportunities for disadvantaged people and promotes social mobility.
- Promotes a responsible supply chain by requiring businesses to compete.
- Leads to a cleaner, greener city.
- Builds stronger more resilient communities.
- Leads to greater innovation and long-term thinking.

Themes	Outcomes
Jobs: Promote Local Skills and Employment	More local people in employment
	More opportunities for disadvantaged people
	Improved skills for local people
	Improved employability of young people
Growth: Supporting Growth of Responsible Regional Business	More opportunities for local SMEs and VCSEs
	Improving staff wellbeing
	Ethical Procurement is promoted
	A workforce and culture that reflect the diversity of the local community
	Social Value embedded in the supply chain
Social: Healthier, Safer and more Resilient Communities	Crime is reduced
	Creating a healthier community
	Vulnerable people are helped to live independently
	More working with the Community
Environment: Protecting and Improving Our Environment	Climate Impacts are reduced
	Air pollution is reduced
	Better places to live
	Sustainable Procurement is promoted
Innovation: Promoting Social Innovation	Other measures (TBD)

Figure 1: The National TOMs comprise 5 Themes, 18 Outcomes supported by 38 Measures

How can social value be measured?

The National Social Value Task Force sponsored by the LGA and supported by Social Value Portal developed and published the National Social Value Measurement (National TOMs) Framework in 2017. The National TOMs were the culmination of over 18 months consultation with over 40 separate public and private sector organisations designed to help organisations identify and measure the social value being delivered through a contract. The TOMs are built around five Themes, 18 Outcomes and 38 Measures (hence the name TOMs) that reflect activities that a potential supplier could provide in addition to the delivery of the core service that they are being engaged for. Typically, this might mean jobs for those furthest from the job market, spend with local SMEs, opportunities for voluntary organisations, environmental improvements and volunteering in the community. Each opportunity is given a value that reflects the fiscal and economic benefits for the community and allows organisations to report their total contribution to society through the contract they are delivering.

How is the Act being applied?

There is no one way to embed the Act and organisations should consider what is best for their communities and suppliers to allow them to collaborate in the way that unlocks the most value.

Despite the fact that the Act is specifically aimed at the commissioning and procurement of services contracts (e.g. consulting services, repairs and building maintenance as a 'service') falling under the EU Procurement Regulations, many local authorities are choosing to extend the Act to cover all of their tendered contracts (services, goods and works) usually above £100,000. In addition, they are looking at how the Act could be included within the planning process.

Across the UK, planning represents an annual opportunity of delivering an additional £15 billion per year

However, there is an emerging consensus on what good practice looks like and public bodies looking to maximise its steps should consider the following:

- Social Value Policy. Ensure that council policies, especially those relating to procurement, mention social value and describe how suppliers must consider it within their proposals.

- Weightings. Ensure that an appropriate and stand-alone weighting is used within the procurement evaluation. Total weightings should be 10-20% requiring bidders to submit a financial proposal (using the TOMs) and a method statement to ensure their supplier has the capabilities of delivering against their pledges.

- Thresholds. Agree on a threshold above which all procurements contain a requirement for social value (e.g., £100,000). This will ensure consistency across the council and sends a clear message to your suppliers.

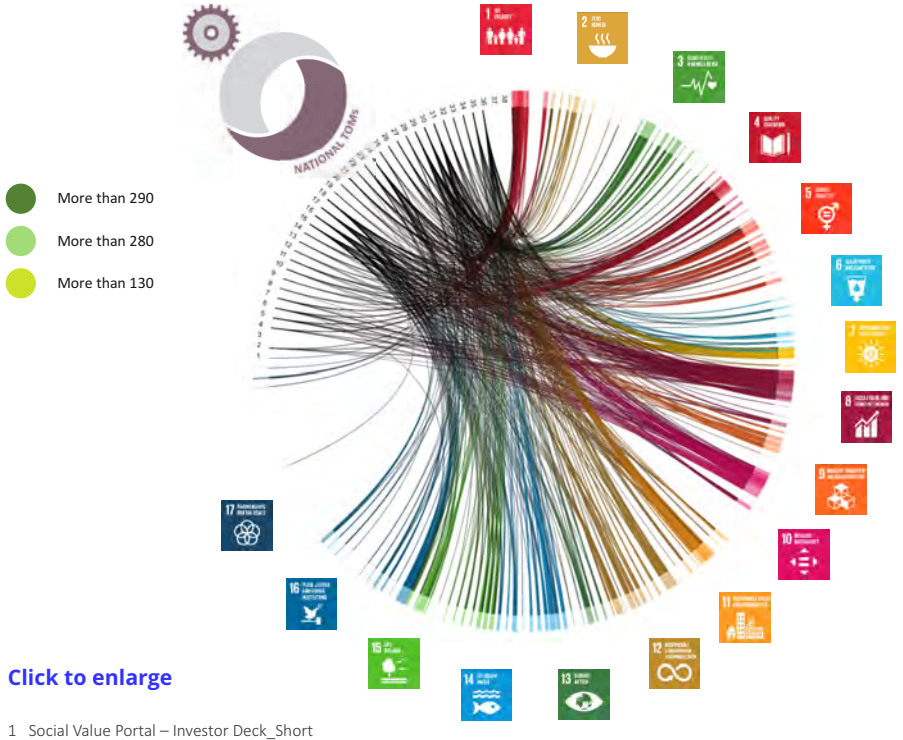
- Build Capacity. Work with your suppliers, especially SMEs and voluntary organisations to help them understand opportunities and provide support to build market capacity.

- Make it easy! Make it as easy as possible for suppliers to understand and deliver social value. You should make all of your policies easily accessible, publish supporting information such as needs analysis and provide links to local delivery partners.

Going global

In 2015, world leaders agreed to 17 goals for a better world by 2030. The Global Goals have now been adopted

Figure 2: The National TOMs can now be used to report a contribution to a Global Agenda



Click to enlarge

1 Social Value Portal – Investor Deck_Short

by 193 world leaders and are designed to catalyse global action in order to end poverty, fight inequality and stop climate change. They require the active participation of all sectors of society: governments, businesses, civil society and the general public.

There is a significant overlap between local government priorities and the Global Goals and as a result the LGA passed a motion at its 2019 annual conference in support of the UN Sustainable Development Goals (SDGs) and the role of local government in delivering them.

There is also a clear alignment between the sustainability agenda promoted by the Global Goals and the social value promoted by the National TOMs Framework and organisations delivering social value through the National TOMs are very likely to be contributing to the Global Goals agenda.

For those organisations that are already contributing or want to start to contribute to the Global Goals agenda, the TOMs can help organisations answer the questions: "How Can the National TOMs Contribute to the Global Goals for Sustainable Development?" – and explore how different Measures contribute to specific Goals.

FAQs

Does embedding social value lead to price increases?

If applied well, with the correct weightings and proper education of suppliers there is clear evidence that embedding social value into procurement delivers additional value; there is no evidence that the Act is leading to price increases as long as appropriate balance in weightings is found alongside 'price' and 'quality'.

What about SMEs?

The TOMs provide a level playing field as all bidders are provided with the same list of opportunities, regardless of their size. However, it is essential that local authorities recognise that SMEs have less resources and that they look at way to build knowledge and capacity in the market place.

What weightings should we use?

Weightings should be high enough to send a clear signal to the market that social value is important but not so high that bidders add costs to boost their social value score. 10-20% is presently recognised as good practice.

What happens if a contractor does not deliver?

The key to preventing failure to delivery is to make sure that suppliers do not over-promise in order to win the work. It is, therefore, essential that the tender documents make it very clear that successful bidders will be contractually held to their commitments and that there are a range of remedies available to councils if a contractor fails to deliver including holding back payments for non-delivery.

What can I learn more about the National TOMs

The National TOMs are 'open access' and can be downloaded for non-commercial purposes free of charge along with detailed guidance and other support at https://socialvalueportal.com/national-toms/ .

THE SOCIAL VALUE PORTAL

Guy Battle
CEO
Social Value Portal
Tel: +44 (0)203 355 0530
guy.battle@socialvalueportal.com
www.socialvalueportal.com

The future of procurement is bright... but are we staring at the sun?

Commercial teams in the public sector are taking huge strides to improve their capability and influence, but do we risk being blinded by undeliverable promises and expectations? Proxima tell us more here about the future of procurement

As Mahatma Gandhi said: "The future depends on what you do today," – achieving the kind of future we want to see will depend on the plans and actions we put in place today.

At Proxima, we've been trying to envision what the future of procurement could look like and how commercial teams can influence their organisations to drive even more value out of their supply chains.

Of course, technological advances will be a part of this; driving efficiency, speeding up decision-making, improving data availability and quality, but other factors and drivers are also coming to the fore in the current climate: social and sustainability objectives, welfare and wellbeing issues, all contributing to an overall desire for "innovation" and "creativity" to meet these needs.

The value equation is, therefore, no longer a simple a cost versus quality comparison but has become increasingly complex as the number of variables multiplies.

Embracing the digital trend

If we don't embrace digital in procurement and commercial, it will embrace us anyway. You can't live a day in the world of procurement without hearing from those anxious to "go digital", to adopt the latest AI, "to automate", to find the edgiest algorithm machine learning etc. etc. But practically-speaking, how applicable is this to solving procurement's issues...?

Our advice to our clients is: don't start by thinking about technology! Think about why you need technology and what benefits it will bring to the way you operate.

Modern procurement professionals are not just trying to go digital; they should be trying to change the value proposition of a future-ready Procurement function. The function of the future is a tech-enabled, high-capability business partner, capable of bringing real market insight to the stakeholders whenever they need it (insight partners), and capable of building networks of suppliers and stakeholders to launch the latest innovative products and services (network partners). The evolution of the commercial function as we see it is shown in the diagram overleaf:

This is really important – technology is going to help enhance and free up from the transactional, through the analytical and eventually to the spot-buy and much of sourcing itself, as well as providing insights further down the supply chain to manage risk. In other words, digital procurement technology is going to shrink the base of the procurement organisation pyramid.

Is the public sector being left behind?

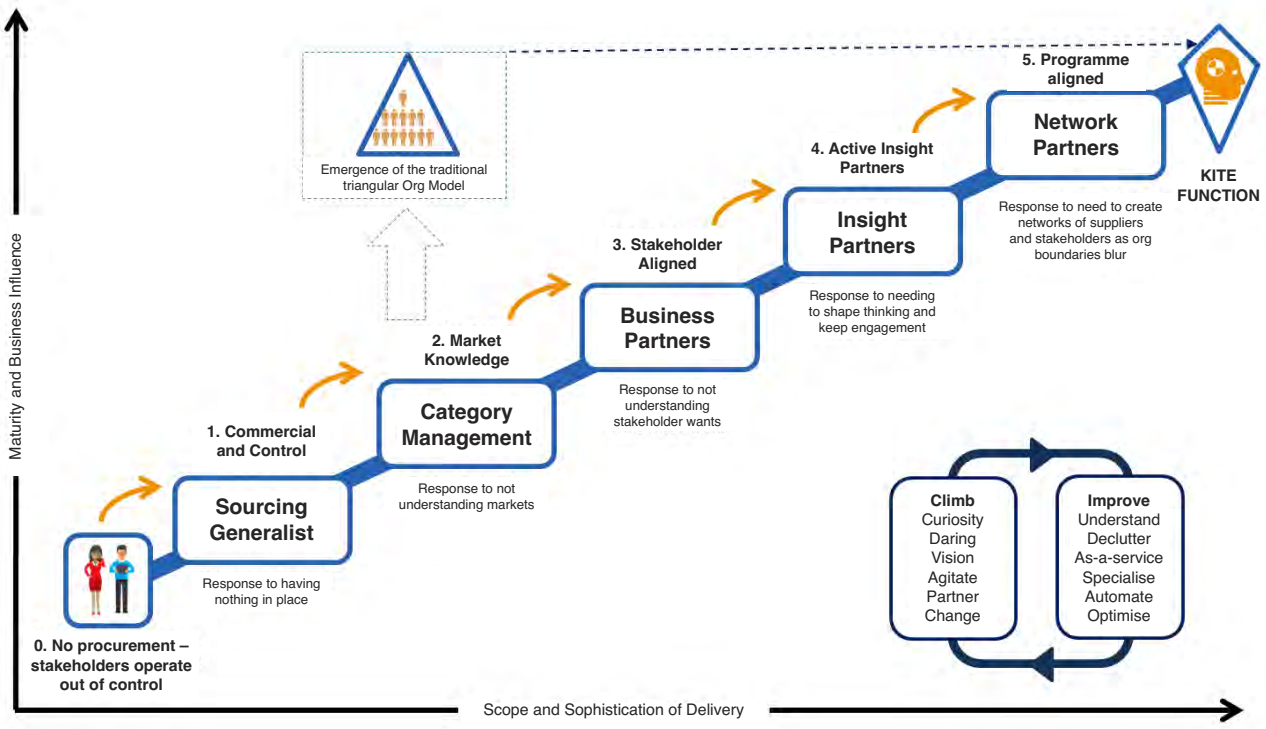
It's very tempting to see public sector procurement as being stifled by bureaucracy and regulation, unable to access the best suppliers and most innovative solutions or practices. Yet that would ignore the great strides taken in recent years to improve the competence, working practices and collaborative working that have been driven by individual departments, the Government Commercial Function, Crown Commercial Service and other cross-functional organisations. It would also underestimate significantly the complexity of the landscape.

Asking colleagues about their experience of working with our clients, we highlighted many ways in which the public sector is actually ahead of the game in best practice management of sourcing and supplier management as well as having the skills to deliver this, such as:

"The processes force more discipline in setting out requirements and how we're going to evaluate them."

"Suppliers don't get complacent due to fixed-term contracts."

"The definition of 'value' can be much broader than simply cost – issues such as social value, sustainability and the use of SMEs make for richer decision-making."



"Suppliers are treated more fairly and in a less cavalier fashion than in much of the private sector."

Yet at the same time, we also see that "some buyers are scared of conversations with the market," "the fear of challenge leads people to default to certain tried and tested procedures," and as a result "buyers' ability to be proactive and develop the market is constrained."

So what's stopping you?

Within the public sector there are some inherent obstacles in the path of a radical change of direction:

1. Investment in technology is frequently constrained by budgets that demand short-term cost reductions from any investment – too often procurement-related investments have historically under-delivered against their business case and other political priorities will often hold sway over "back office" investments.

2. Regulations – the perception that public contracts regulations (PCR 2015) hinder the effective use of supply markets is strongly-held in many organisations. Supplier days, innovation forums and an increasing use of negotiated procedures and even innovation partnerships are all examples of public sector teams embracing the need to work with suppliers.

3. Government policies – there's a lot for the modern-day commercial professional to do alongside 'traditional' procurement activities: many new policies and drivers are coming to the fore, such as social value, where suppliers need to show how they can help improve society by tackling issues such as modern slavery and climate change, and; prompt payment, especially to SMEs, to increase resilience in the supply chain.

4. Cultural – resistance to change and the reliance on "how we've always done things" is probably the one way in which public sector buyers and stakeholders may fail to grasp the opportunities the future could bring; and in this, it is no different to the private sector.

So, take inspiration from the many good news stories from across Government Commercial, and in particular use the Government Commercial Function's role in sharing best practices and building coordinated strategies and approaches. In order to drive tangible behaviour change, departments now need to consider how to practically adopt these best practices into everyday ways of working, and track their own journey to meet the higher commercial standards which are now expected and achievable in this new era of Government Commercial.

Proxima
Procurement is our business

Claire Foxall
Executive Vice President, Public Sector
Proxima
Tel: +44 (0)20 3465 4500
Claire.foxall@proximagroup.com
www.proximagroup.com
www.twitter.com/Proxima_Group

Procurement: Engaging third-party resources

Gareth Clark, Deputy Director – Professional Services, Crown Commercial Service guides us through a number of agreements that the organisation offers when it comes to procurement (engaging third- party resources)

Crown Commercial Service (CCS) offers a number of agreements through which organisations can engage third-party resources but there are important considerations when making the decision about the right way to buy: often your choice will be to decide whether the requirement can be fulfilled via either a contingent labour or consultancy solution. The distinction is important and we at CCS urge customers to consider it carefully before embarking on the process:

- If you need a temporary worker for business-as-usual or service delivery activities, you need a contingent labour solution; this includes interim managers and specialist contractors. The worker will more than likely be part of a team and be line managed on a time basis rather than output. A typical example of a contingent labour solution is back-filling a permanent hire who may be on long-term sick or maternity leave. Contingent labour can also be used on a specific, time-limited project.

- However, if you're looking for objective, time-limited advice outside the business-as-usual environment when in-house skills aren't available, you need consultancy support. Consultancy tends to relate to the strategy, structure, management or operations of your organisation to help you achieve your objectives. They might work outside of business as usual hours, define a level of resource, assume a degree of risk, solve a problem for you, set outcomes and be paid based on output.

If you have concerns over how to resolve your contingent labour versus consultancy assessment, please get in touch with us. Once you've decided which you need, you can access the relevant CCS commercial agreement.

For contingent labour and contractor requirements, you should use Public Sector Resourcing (RM3749). Our strategic partner, Alexander Mann Solutions (AMS), provides a fully managed service for hiring contingent workers. The solution also offers a direct-hire aspect whereby workers can apply directly into departments for a role, rather than going via an agency – see The PSR Market Place. This can drive significant cost and time savings.

"Crown Commercial Service (CCS) offers a number of agreements through which organisations can engage third-party resources but there are important considerations when making the decision about the right way to buy: often your choice will be to decide whether the requirement can be fulfilled via either a contingent labour or consultancy solution."

The AMS team provides sourcing, on-boarding, vetting and will guide you through the recruitment process with fixed rates to ensure simplified pricing. This commercial agreement also addresses issues including agency worker regulations and will monitor your off-payroll working in the public sector (IR35) through the SAP Fieldglass technology platform and general data protection regulations.

Departments need to provide their internal spending controls to ensure full authorisation from both finance and HR teams before AMS starts any recruitment.

Alternatives to this commercial agreement apply if your contingent labour needs are in a specialist sector such as health and social care. NHS customers can use Non Clinical Temporary and Fixed Term Staff (RM6160) for all non-clinical staffing needs, from admin to estates, portering to catering, both temporary and


Gareth Clark

fixed-term. It delivers the best commercial deal with a range of transparent rates and flexible discounts available, protection in the terms and conditions and stringent audit and assurance processes to ensure worker compliance in line with NHS Employers' CHECK standards.

In addition, there is:

- Quick on-boarding and direct contact with suppliers.
- Help with selection through our skills matrix, award support tool, and region and skills matrix.
- Ability to direct award.
- Management information is available for all customers to detail reported spend and market analysis.

The Supply Teachers and Temporary Staff framework (RM3826), sponsored by the Department for Education, can be used by educational establishments to recruit temporary and fixed-term teaching and non-teaching staff. This includes qualified and unqualified teachers, education support staff, headteachers, and non-classroom based roles such as IT, finance and admin and clerical.

The framework provides:

- Robust safeguarding processes in accordance with the Keeping Children Safe in Education guidance, with suppliers audited by an approved accreditation body.
- Consistent terms and conditions, transparent pricing including free temp to perm provisions after 12 working weeks.
- A preferred supplier list containing local suppliers identified through the agency selection tool.
- Opportunities to work with a single managed service provider responsible for supporting all temporary staffing requirements, managing your supply chain and implementing technology.

However, if you have consultancy requirements such as audit, finance, ICT/digital services, infrastructure, business design or strategy, you should use one of our Management Consultancy commercial agreements.

All suppliers are Cyber Essentials accredited and offer standard terms and conditions. If you opt for the consultancy route, please ensure you follow the relevant spending controls for your organisation and get any required approvals before starting your procurement. You may achieve greater savings through further competition and you will achieve a better outcome when you engage with the market early.

So whether it's for contingent labour or consultancy, our expert teams can help you find the right solution.

For further advice complete this online form, email info@crowncommercial.gov.uk, or call us on +44 (0)345 410 2222. ■

Gareth Clark
Deputy Director – Professional Services
Crown Commercial Service
Tel: +44 (0)345 410 2222
info@crowncommercial.gov.uk
www.gov.uk/government/organisations/crown-commercial-service
www.twitter.com/gov_procurement

NEPO: Achieving benefits through collaborative procurement

NEPO is a public buying organisation based in the North East of England, with a portfolio of procurement solutions available for national use. Steven Sinclair, NEPO's Procurement & Commercial Director, talks about the opportunities and ambition of collaborative procurement in the UK public sector

Since 1976, NEPO has worked in collaboration with public sector partners to deliver procurement solutions that drive benefits for end-users, communities and supply chains. NEPO works in partnership with North East local authorities and the wider public sector to identify and develop innovative procurement solutions. NEPO's reach extends further, with national take-up of our portfolio of procurement solutions through a free-of-charge associate membership scheme.

NEPO is unique in its collaborative approach and our solutions are developed by the public sector, for the public sector.

Working nationally

NEPO has over 500 associate members from across the UK. Our members represent a range of public sector organisations including local authorities, central government departments, NHS, higher education, further education, schools and academies, housing associations, emergency services and charities. These members are able to access NEPO's nationally accessible procurement solutions, covering a range of categories including energy, construction, fleet, facilities management and professional services.

Public sector organisations wishing to access NEPO's solutions can do so via an associate membership scheme. There is no cost to join, simply visit nepo.org to get started.

Flagship solution

NEPRO, the neutral vendor managed service solution for appointing specialist professional services, is our most popular solution, accessed by over 350 public sector organisations.

Since its inception in 2012, NEPRO has developed into a market-leading solution that provides public sector organisations with choice, speed to market and control when appointing specialist professional services. NEPRO features a supply chain of over 6,000 suppliers and over 60% of spend through the solution is with SMEs. In 2018, the Department for Education (DfE) added NEPRO to its 'Deals for Schools' endorsement, a list of frameworks that DfE have assessed for compliance, ease of use, user feedback and value for money. NEPRO is the only listing within the professional services section of the deals.

From September 2019, NEPRO³, the third evolution, will be available for national access. Working with our delivery partner Bloom, NEPRO³ will continue to offer choice, value and speed. In addition, NEPRO³ will bring a greater focus to the buyer and supply chain alike by facilitating a user community for sharing best practice and exploring collaboration.

NEPRO is just one of over seventy procurement solutions within NEPO's portfolio. Other nationally accessible solutions are available to view at nepo.org and include:

- Furniture.
- Fleet solutions.
- Travel management.
- Agency Staff.
- Stationery.
- Prepaid Card Accounts.
- Electricity and Gas.

Suppliers and social value

There is vast potential for the public sector to add value through collaborative procurement and NEPO has embraced this opportunity.

NEPO has invested in a supplier development programme that upskills suppliers and promotes public sector opportunities. NEPO Business Club

offers free training on a range of skills related to public sector tendering, 2018 saw over one thousand suppliers attend NEPO Business Club events and third-party expos.

Public sector procurement should add value beyond the goods and services being procured and should positively impact communities, local economies and the environment. With this in mind, NEPO launched a number of pilot projects to trial measurement of social value using the National Themes, Outcomes and Measures (TOMs) framework. The pilots cover a range of procurements including solutions for electricity, agency staff, consultancy and training providers. To date, five of the pilot projects have been awarded and have calculated a proxy value of £135 million in social value commitments, including apprenticeship schemes, school engagement and community volunteering. This success has resulted in NEPO adopting the TOMs framework across all new procurement activity.

Steven Sinclair,
Procurement & Commercial Director

What's next for NEPO?

NEPO has entered an exciting phase, with a revitalised strategy that features a strong commercial focus. This will see the organisation further support its associate membership base, export North East supplier talent across the UK and extend a greater range of offerings beyond the public sector through different operating models.

Collaboration continues to underpin everything we do. NEPO's successful strategic partnership with The Procurement Partnership Limited (TPPL) on a range of fleet solutions is a testament to the opportunities in this area. In addition, cross-government collaboration through our chairmanship of the Government Commercial Function Northern Group and membership of the LGA National Advisory Group ensures that best-practice and leadership are at the core of our activities.

NEPO will also continue to identify innovative ways to address public sector challenges. We are currently working with colleagues in Yorkshire and Humber (YORprocure) on 'Open', an ambitious project to develop a single system that seamlessly fulfils public sector requirements for spend analysis, procurement and contract management. Open will enable insightful and informed decision-making, whilst providing supply chains with a transparent and user-friendly platform for doing business with the public sector.

open

analyse procure manage

nepo®

Steven Sinclair
Procurement & Commercial Director
NEPO (North East Procurement Organisation)
enquiries@nepo.org
www.nepo.org
www.twitter.com/NEPOprocurement

Customer rating review systems and UKAS accreditation

Suzi Daley, External Affairs Manager at United Kingdom Accreditation Service (UKAS), focuses her thoughts on customer rating review systems online and UKAS accreditation in the health and social care system

Recent events like "Dieselgate" and the PIP breast implant scandal have seen an erosion of trust in self-declarations of conformity, resulting in a move towards a peer-review culture. Dating back to the 17th Century, peer-review of research articles is a long-established and important part of the scientific and academic communities. The advent of the internet and web-based technology has decoupled peer-review from its original environment and made it more accessible to the professional and consumer sectors. Previously ad hoc recommendations from trusted friends, fellow professionals and industry experts have effectively been widened and formalised, with the creation of dedicated review sites such as Checkatrade and TripAdvisor, as well as retail platforms such as Amazon and eBay incorporating review functions into their systems.

However, these customer rating review systems themselves are not without their faults and are open to exploitation. In addition to customers increasingly suffering from review fatigue, the largely anonymous and unaccountable nature of modern review systems is cultivating a thriving "fake review" industry. Which? recently described the number of fake reviews on Amazon as unacceptable, whilst the Competition and Markets Authority (CMA) is urging eBay and Facebook to take action against the numerous fake review services that are being offered via their platforms. Governments across the world are scrambling to get ahead of the evolving fake review industry; with the CMA warning that it's illegal to either solicit or write fake reviews, U.S. Congress summoning the Chief Executive of Amazon to explain what his company is doing to tackle the issue and the Italian courts sentencing a man to nine months in prison for selling fake TripAdvisor reviews.

As well as over-inflated "five-star" fake reviews, there is a similar problem with malicious "one-star" ratings given by competitors or those with an axe to grind. The overall effect is that bias is creeping into the peer-review system, skewing the playing field and eroding trust in the system's integrity.

Review sites still have a valid role to play in modern vetting systems. Indeed, in its recent Market Study on Statutory Audit Services, the CMA is recommending giving the regulator the power to appoint a reviewer "to improve audit quality and by introducing an additional, independent quality check" in certain pre-defined circumstances.

The underlying theme is that in order for review systems to be trusted, they need to be robust, measured against the same universally accepted standards and independently verified. However, there is no need to reinvent the wheel as the process of accredited testing, inspection and certification are already delivering confidence in the integrity of peer-review systems in a wide number of fields.

The United Kingdom Accreditation Service (UKAS) itself is subject to a peer-review process by other national accreditation bodies from overseas. In the health and social care system, UKAS accreditation helps deliver confidence in the competence and impartiality of both clinical peer reviews and scientific data. UKAS is part of the NHS England Knowledge Partnership Network programme, which aims to enable the information exchange between clinical and scientific leaders of high-value new approaches to improving patient outcomes, increasing efficiency and inward investment in life sciences. Following a submission to the Care Quality Commission (CQC) third party peer- review and accreditation scheme panel, three UKAS healthcare accreditation schemes (Clinical Pathology Accreditation, the Imaging Services Accreditation, and Physiological Services (IQIPS)) are now formally recognised as part of the CQC inspection programme. UKAS also accredits organisations that carry out a peer-review of health and social care

"In the health and social care system, UKAS accreditation helps deliver confidence in the competence and impartiality of both clinical peer reviews and scientific data."

services against quality standards developed from National guidance.

Far from being unique to the health and social care sectors, the principles, benefits and lessons learned from UKAS accrediting these peer-review systems are readily transferable to other industries. UKAS is currently engaged in liaising with government and the regulators to identify the peer-review sectors where accreditation would be most effective and would welcome dialogue with industry bodies, key stakeholders and other interested parties.

About UKAS

The United Kingdom Accreditation Service is the sole national accreditation body recognised by the UK Government to assess the competence, integrity and impartiality of organisations carrying out conformity assessment activities e.g. testing, calibration, inspection and certification against international standards. UKAS accreditations underpin a wide range of economic and other activities, as well as government policy in areas such as environmental management, food safety and quality, medical services and forensic science. More recently, we have been working with government and industry partners to develop new schemes in areas such as climate change, aesthetic medicine, cybersecurity and the internet of things (IoT).

If you would like more information about what we do and how we could help you deliver your policy outcomes, please contact Suzi.Daley@ukas.com

UKAS
UNITED KINGDOM ACCREDITATION SERVICE

Suzi Daley
External Affairs Manager
United Kingdom Accreditation Service (UKAS)
Tel: +44 (0)1784 428 802
Suzi.Daley@ukas.com
www.ukas.com
www.twitter.com/UKAS

Procurement: Making bench contracts work

David Mann, Managing Director, dxw digital shares his expert thoughts on making bench contracts work, including the UK Government's G-Cloud and Digital Outcomes and Specialists (DOS) frameworks

The G-Cloud and Digital Outcomes and Specialists (DOS) frameworks are some of the great successes of government tech procurement, thanks to an ethos of agile procurement.

We've been on both since they launched and recently noticed a worrying trend of government departments using the Digital Marketplace to procure so-called 'bench contracts'.

These are where a buyer procures a team or individuals with particular specialisms at short notice. Done the right way, it could be a way to fund teams rather than projects, or take a "one team, many outcomes" approach. But if they go wrong (and they often do) they risk reducing the ability of teams to do good work and as a result, erode the quality of public services. They can disadvantage smaller firms, yet these frameworks were put in place to help the public sector benefit from the agility and innovation of the self-same small and medium-sized enterprises (SMEs).

After 14 years working in central government, I understand commercial realities and why bench contracts are attractive. They offer buyers the flexibility to draw down against existing contracts to bring in teams or individuals to meet challenging deadlines in shifting contexts, without having to engage in drawn-out business cases, procurement exercises, evaluation and everything else required to bring in suppliers.

However, the pressure to spin up teams or provide individuals at very short notice – often two weeks – reinforces short-termism and impacts on quality. Working this way doesn't help organisations build their own capability or retain history and institutional memory. And no good supplier is going to have a team of great people waiting for a call. They can juggle their schedules to spin up teams quickly, but this means shrinking or swapping teams elsewhere, which will impact on other clients' projects. Some larger suppliers might have a number of juniors available, but it's unlikely they will have experienced staff on standby with the capability to build services that meet the Service Standard.

Making it work

At dxw, we always engage constructively to find the right way ahead. Companies who have won contracts like this have the practical experience of how to get the best value from them.

We recently attended a Crown Commercial Service-sponsored event with some of our SME peers where we talked about many of these issues and look forward to more. As a community, we have to get this right or we risk a return to the oligopoly of old where a small number of big suppliers dominate and we all suffer the consequences of poor service delivery.

In the meantime, as bench-style procurements become more common, we've identified four things that would help them create better outcomes for both users and buyers and ultimately for all of us as taxpayers.

1) Set realistic start dates

The pressure to start immediately means neither buyer nor suppliers are ready to achieve anything valuable. This means the first few weeks of any engagement are spent getting the team in a position to start work and understand the brief.

Sensible start dates and mobilisation times would give suppliers sufficient time to mobilise the right team for the job. Just as importantly, they would give buyer teams time to be ready to start work.

David Mann, Managing Director

2) Genuinely work together

Bench contracts require a close partnership and trust to deliver real value for users and buyers alike. That means a partnership where the suppliers can use their expertise to influence and shape the project portfolios to best meet the needs of users. Partnerships can be particularly helpful to build capability and support for smaller and medium-sized organisations, or functions, where a small number of experienced people can make a huge difference to the future success of the work.

Public sector organisations need to work alongside their chosen supplier, as the supplier will not have the knowledge of the business and ability to operate within it without that context. For example, current work with the Maritime & Coastguard Agency is an example of a partnership to deliver a series of projects, all working towards the same organisational goal, that is to become a digital organisation. Therefore, one begins with the confidence that a pipeline of future work lies ahead and can be staffed appropriately.

Buyers need to honestly appraise their internal capability and ability to operate these type of arrangements. Managing a large portfolio of work is hard, even for the most digitally mature organisations. It requires experience to understand the necessary trade-offs and inevitable compromises, while maintaining a focus on user needs and quality.

3) Use the Service Standard

The Service Standard is not a veneer that can be applied after work is done. It must be the bedrock on which the product or service is researched, built and operated. The danger with rapid deployment and the pressure to deliver fast means that corners will be cut. Meeting the Service Standard should not be one of them.

4) Encourage partnerships

One of the ways these contracts could add value is if they are designed to be as friendly as possible to SMEs working together. Different companies bring complementary skill sets and capabilities. For example, we currently partner with Content Design London, AI research consultancy Oxford Insights and Sheffield based researchers Paper.

One company recently won a two-year contract to help Ofsted run discoveries. A specific part of the procurement focused on the other organisations the company worked with and the capabilities and specialisms they brought. There were also questions about how the company could scale to support multiple projects at any one time. The language was key: the buyer was explicit in describing how the opportunity was suitable for SME partnerships. Buyers want to access the best talent available and working with more than one SME is an effective way to do this.

What next?

The success of the GCloud and DOS frameworks to date has been because they've met the needs of procurer and supplier while providing better services to the end-user. As a community, it's up to all of us to work together to ensure they continue to do so. ■

David Mann
Managing Director
dxw digital
Tel: +44 (0)345 257 7520
contact@dxw.com
www.dxw.com
www.twitter.com/dxw

The Tip of the Iceberg – but what lies beneath?

NFI 2016-2018 report confirmed £4.3m in 'Error payments' made to Suppliers (£4.5m – previous period), out of £275m in overall errors identified. Does this make sense?

Government has concluded that the potential range for likely losses in unmeasured areas of government spend ranges from £1.96bn to £19.6bn, or 0.5% to 5.0% of public services expenditure.

(source: Cross-Government Fraud Landscape Annual Report 2018, published by the Cabinet Office)

What proportion of potential errors relate to Spend with Suppliers (Trade Creditors)?

With £100m's being identified and recovered in error payments to Suppliers within the Private Sector, why would the Public Sector be any different?

Is it time to find out what lies beneath…

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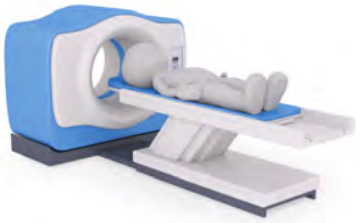
Twice2much Supplier Health Check

Our reviews enable Clients to benefit from a detailed forensic review of their Accounts Payable transactions bespoke to their own organisation.

To draw an anology with our own Health, we would compare our reviews to an MRI/scan approach rather than a GP check-up. The depth of our reviews enables the identification of errors previously unknown to the organisation.

STAGE 1 - Identification/detection

- Access to £100,000's of technology, analytics and resources
- Access to dedicated experienced professionals
- Provides multiple-layer interrogation of transactions with Suppliers
- Specialist expertise in reviewing Supplier transactions and identifying anomalies



STAGE 2 - Verification/validation

- Expert detailed analysis of transactions at individual Supplier level to validate and investigate anomalies
- Obtaining evidence to support initial findings

STAGE 3 – Recovery/Reporting

- We supply the system, processes and resources to recover the errors found on our Clients' behalf
- Flexible but targeted reporting provides significant additional benefits to Clients

Our Supplier Health Checks are carried out on a NO RECOVERY - NO FEE basis enabling Clients to benefit from a FREE Health Check if no errors are found.

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Crown Commercial Service *Supplier*

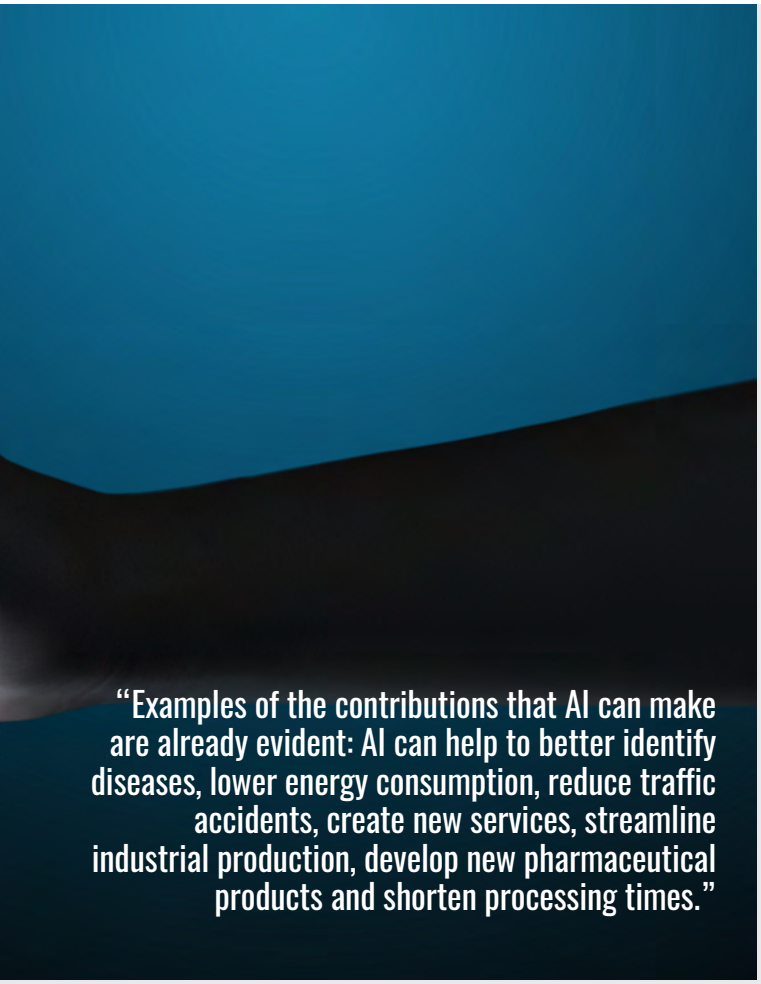
The exciting future of digital development in Sweden

The exciting future of digital development in Sweden is explored here, with a focus on the potential of artificial intelligence

According to the Government of Sweden, digital policy is about promoting and utilising the opportunities that digitalisation offers. Also, it incorporates regulation of electronic and digital communications, network and information security, for example, plus digital infrastructure and broadband access. This important area of public policy in Sweden also concerns e-government issues, such as using digital policy to ensure the activities of government agencies are more efficient and to simplify how the public makes contact with them, for example, using electronic signatures and open data.[1]

Anders Ygeman is currently Minister for Energy and Digital Development, within the Ministry of Infrastructure[2]. On the subject of digital development, we read that in June 2019, Prime Minister Stefan Löfven met French President Emmanuel Macron in Paris, France, where the countries' strategic partnership for innovation, digital transformation and green solutions was deepened and updated.

It is worth noting here that when the aforementioned gentlemen originally entered into this partnership back in November 2017, it was agreed that Sweden and France needed to work together in several strategic areas to better deal with digital transformation and climate adaptation. This partnership is going forward in the future, especially where sustainable development in artificial intelligence (AI), 5G and a fossil-free transport sector are concerned, as well as achieving inclusive climate-neutral cities by 2030.



"Examples of the contributions that AI can make are already evident: AI can help to better identify diseases, lower energy consumption, reduce traffic accidents, create new services, streamline industrial production, develop new pharmaceutical products and shorten processing times."

"It is natural that we cooperate to benefit from digitalisation and speed up the green transition through investment in artificial intelligence and batteries, areas where Sweden and the largest EU Member States are at the forefront. They are central to a European industrial strategy," Minister for Enterprise and Innovation Ibrahim Baylan comments.[3]

Picking up on the aforementioned theme of AI, you may like to know that the Swedish Government has identified an overall direction for such work in Sweden and to lay the foundation for future priorities, here. One highlight of this document is how AI can make a massive contribution to the economic growth of Sweden, amongst other areas.

"AI has the potential to contribute significant benefits in a variety of areas through increased economic growth, and solutions to environmental and social challenges. According to some studies, the use of AI has great potential to increase economic growth.

"Examples of the contributions that AI can make are already evident: AI can help to better identify diseases, lower energy consumption, reduce traffic accidents, create new services, streamline industrial production, develop new pharmaceutical products and shorten processing times."[4]

Anders Ygeman

I commend you to read more about this very exciting area of AI but let's finish by looking at how in 2018, the Nordic and Baltic regions expanded their cooperation to keep their position as Europe's leading region in the policy area of digital development. The then Minister for Housing and Digital Development, Peter Eriksson said: "Our region is currently the European leader on digital development. Today's AI declaration means expanding the cooperation between our countries. Now Sweden is also taking on the responsibility of leading the Nordic-Baltic cooperation into the next stage, by moving the work forward and proposing necessary measures."[5] ■

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"The council that solved Brexit": Digital transformation and better business process for local authorities

Fotis Talantzis, CEO & Co-Founder of Novoville tells us how councils can solve Brexit by transforming public services with digital

Brexit has been the centre of UK politics for some years already, with people on both sides of the debate arguing that leaving or staying in the European Union (EU) will have an immediate effect on their quality of life. Yet, a recent article in the FT titled "What the UK's 'left-behind' areas want after Brexit" highlighted that better public services, more tight-knit communities and increased job opportunities were key concerns for both sides.

Indeed, for the population, the perception of how well the EU or the British government is doing is often amalgamated with how well their local authority is performing. After all, it's all about the simple things: are jobs staying in the area? Is my neighbourhood safe? How easy and quick is it to apply for a benefit or access a government service if I have to? Regardless of where people stand on Brexit, there is an overarching concern with the 'Local'.

One of the EU's working principles, subsidiarity, holds that problems of a certain scale must be tackled on that same scale. This is why we don't expect the EU to issue directives related to local bin collection frequency or local library opening times. Yet, although states have put a lot of effort into pooling sovereignty "up" to tackle, say, the movement of goods and people, they have often been bad at pooling sovereignty in the opposite direction. They have not sufficiently empowered local authorities to increase citizen participation in decision-making at a local level or allowed councils to invest in improving access to and delivery of local services.

Developments in technology provide an opportunity to become more responsive to public needs, modernise service delivery and increase transparency. Local governments can be at the centre of this digital transformation. The reason is simple: they interact with businesses, citizens and other public service organisations with a very high frequency, generating a myriad of granular data. However, keeping pace with the expectations of digital citizens, exploiting data and making the right organisational changes is difficult. In an adverse budgetary context, it may seem like there are other, more pressing priorities.

We know that austerity has left local governments fighting to keep the lights on in the UK. In Scotland, devolution hasn't meant that local authorities have the funding or staff required to fulfil their new missions. Residents everywhere complain that libraries close, doctors disappear and that communication with the authorities is

Fotis Talantzis

inadequate. A recent LGA poll on resident satisfaction with councils found a significant decline between 2013 and 2018, with residents "feeling well-informed" dropping by 17% and "satisfied with the local council" falling by 13% during the period. Such deteriorating customer experience is concerning.

> "Our company, Novoville, is making it its mission to save the local, and re-establish trust between people and government. That's why we offer a civic engagement platform which transforms the way citizens interact and transact with their local government, reducing friction and costs."

We believe that putting local residents back at the centre of the frame and harnessing their collective intelligence is a key part of the solution to this crisis of the 'local', with positive consequences for the country as a whole. Contrary to what most in the sector

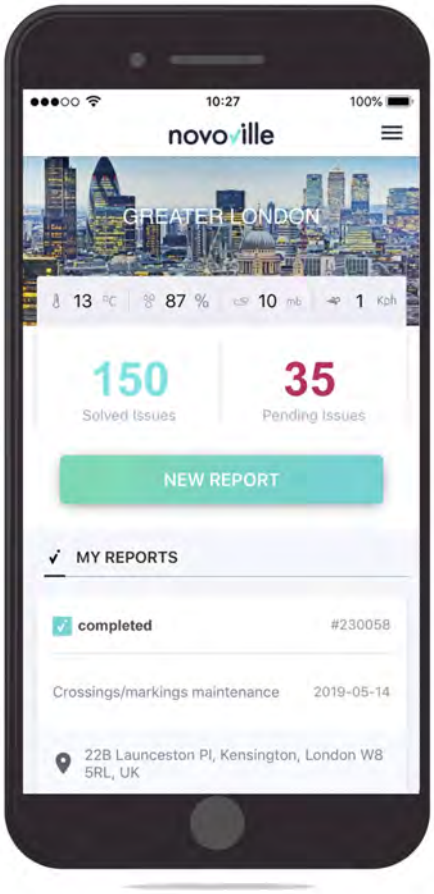
believe, this doesn't hinge on spending lavish sums of money on grand transformation programs, but it does have a lot to do with applying new technology intelligently and improving business processes incrementally to deliver open, responsive and participatory public services.

To achieve this, emphasis must be placed on both access and delivery of services. If you improve the interface with residents, but delivery is not efficient, all you're doing is raising residents' expectations and creating more work for the council's staff. If you fail to improve the interface with residents, however, their satisfaction and engagement rates will continue to drop, accentuating this impression of being ignored or left behind.

Our company, Novoville, is making it its mission to save the local, and re-establish trust between people and government. That's why we offer a civic engagement platform which transforms the way citizens interact and transact with their local government, reducing friction and costs.

It allows councils to capture all incoming resident communications and issues in a single system. It gives residents access to all the digital services offered by the council in one place. It allows everyone to engage with their local authority using whichever channel best suits their needs: a free mobile app, web app, chatbots, or social media. Everything is intuitive, the experience the same across devices, and it's built to enable dialogue.

Yet, we know that technology itself isn't a silver bullet. That's why Novoville always starts by auditing and improving business processes. We also know that simply making technology available is no guarantee that people will use it. That's why Novoville



also helps with the process of reaching out to residents, raising awareness about local matters and engaging with them on social media.

At Novoville, we take a piecemeal approach: we solve problem by problem and improve process by process. We don't impose multi-million pound contracts or locked-in multi-year deals. We offer training, technology and transfer of skills, and we deliver it in two to three months. Our focus is solely on empowering the Local.

In councils like Watford and Guernsey, Novoville has tripled responses to consultations on local matters. Using our in-house chatbot technology, councils can start an automated discussion and collect local intelligence on any popular chat application. Thousands of people have already voiced their opinion quickly and easily, achieving an average of 65% re-engagement rate. This costs 20% of traditional consultation methods...

For cities as large as Athens (700,000 residents and 2 million daily commuters), Novoville has served as a state-of-the-art CRM system. Within six months of Novoville operation, post-crisis Athens handled more than 60,000 citizen requests and resolved 84% of them. New processes have saved thousands of man-hours, increasing municipal services' efficiency by 24%. Three months later, Novoville complemented this with a brand-new parking app able to integrate sensor data (e.g. occupancy of a parking spot) in real time. On the whole, with an easy way to report a local problem, give their opinion, and buy mobility in the city, residents feel listened to and their city finally feels like it's improving.

Athenians are not alone: at present, 3 million people around Europe have started rebuilding their relationship with the local through Novoville.

Whether you're a diverse regional city, a market town or a rural community, Novoville can help you solve your key local issues. Over time, this will have a big impact on the perception of problems that have led to decisions as important as Brexit. The local is the key to a bottom-up regeneration of more democratic, sovereign and independent communities. That's a good start for the country.

novoville

Fotis Talantzis
CEO & Co-Founder
Novoville
Tel: +44 (0)207 442 5551
info@novoville.com
www.novoville.com

EU: Who are the new European Commissioners?

Here, we discuss the freshly elected European Commissioners of the 2019-2024 period, including their duties and a vision of the EU their work could shape

The President of the European Commission is the first woman to hold the role, Ursula von der Leyen. Voted in on 16th July 2019, she is described by the Commission as a "European by heart and by conviction", with an aspirational climate plan to make Europe the first climate-neutral continent by 2050.

Her Commission is gender-balanced, and she further urges her Commissioners to consider the talents of all in the European Union (EU) regardless of race, sexuality and gender for the formation of their own cabinets.

In Leyen's agenda for the future, she said:

"It is an aspiration of living in a natural and healthy continent. Of living in a society where you can be who you are, live where you like, love who you want and aim as high as you want. It is an aspiration of a world full of new technologies and age-old values. Of a Europe that takes the global lead on the major challenges of our times."

With 200 million voters in 28 EU countries going to the polls to elect MEPs in May 2019 and the ongoing uncertainty of Brexit negotiations, the executive body of Europe has taken on a new level of significance. This Commission will sit from 2019 to 2024.

On 10th September, she announced a list of new Commissioners, who are currently waiting to take their new posts.

Who are the new Commissioners?

Executive Vice-Presidents

- Valdis Dombrovskis, Latvian, An Economy that Works for People.
- Frans Timmermans, Dutch, European Green Deal.
- Margrethe Vestager, Danish, Europe fit for the Digital Age.

Vice-Presidents

- Josep Borrell, Spanish, also High Representative, A Stronger Europe In the World.
- Margaritis Schinas, Greek, Protecting our European Way of Life.
- Maroš Šefčovič, Slovak, Interinstitutional Relations and Foresight.
- Věra Jourová, Czech, Values and Transparency.
- Dubravka Šuica, Croatian, Democracy and Demography.

Commissioners

- Stella Kyriakides, Cypriot, Health.
- Sylvie Goulard, French, Internal Market.
- Paolo Gentiloni, Italian, Economy.
- Phil Hogan, Irish, Trade.
- László Trócsányi, Hungarian, Neighbourhood and Enlargement.
- Helena Dalli, Maltese, Equality.
- Janusz Wojciechowski, Polish, Agriculture.
- Elisa Ferreira, Portugese, Cohesion and Reforms.
- Didier Reynders, Belgian, Justice.
- Rovana Plumb, Romanian, Transport.
- Ylva Johansson, Swedish, Home Affairs.
- Janez Lenarčič, Slovenian, Crisis Management.
- Jutta Urpilainen, Finnish, International Partnerships.
- Kadri Simson, Estonian, Energy.
- Virginijus Sinkevičius, Lithuanian, Environment and Oceans.
- Johannes Hahn, Austrian, Budget and Administration.
- Mariya Gabriel, Bulgarian, Innovation and Youth.
- Nicolas Schmit, Luxembourgish, Jobs.

A look at some of the key players:

1. Frans Timmermans, European Green Deal

Timmermans began his career in 1980, with a degree in French language and literature. He worked his way through foreign affairs and embassies, joining the Partij

van de Arbeid (Dutch Labour Party) in 1998. His last role in the EU was related to Inter-Institutional Relations, the Rule of Law and the Charter of Fundamental Rights.

His new portfolio is the European Green Deal, which includes "leading international negotiations" to encourage other States to increase their environmental ambition, and putting forward a cohesive "Just Transition Fund" to help those most affected during the Green Deal transition, e.g. coal regions.

2. Maroš Šefčovič, Interinstitutional Relations and Foresight

Moving from the Energy, Space policy and (temporarily) the Digital Single Market portfolio to this one, Šefčovič is being returned to the department he worked for in 2010-2014. He has been given a legislative focus in contrast to the applied policy and cacophony of evolving topics in his former role.

He is now to focus on elements such as "the Commission's work on the European Battery Alliance" and help Member States to "avoid unnecessary additional red tape" when converting "EU legislation into national law."

3. Stella Kyriakides, Health

Starting with a degree in Psychology, Kyriakides then worked in several roles that touched on National Cancer Strategy and clinical psychology, becoming a representative to the European Commission on health matters in 2018.

She is now focusing on the Health portfolio, which includes fighting vaccination myths, ensuring "the supply of affordable medicines" for Europe, and the "Farm to Fork" strategy, which focuses on the food chain to support a circular economy and further ensure sustainable practices.

4. Kadri Simson, Energy

With a degree in history and subsequently political science, Simson moved through advisory and research roles, even working for NATO. As of 2009 she became a member of the Estonian Centre Party, through which she became the Leader of the NATO parliamentary assembly delegation for Estonia. From here, she joins the European Commission.

Her Energy portfolio largely overlaps with the European Green Deal, with goals to rapidly implement clean energy, the potential of affordable liquefied natural gas, and the design of the "new Carbon Border Tax". In the mission letter, the new president emphasises that 50 million European households are unable to afford heating and highlights solving this crisis as a priority.

5. Virginijus Sinkevičius, Environment and Oceans

Sinkevičius has worked in economic policy and with farmers, whilst also spending time as an editor after attaining his Master of Arts in European Studies. He was formerly Minister of Economy and Innovation, which lends to the current role managing Environment and Oceans. President Leyen describes the natural resources of the EU as "great natural and economic wealth", highlighting the importance of an economist's mind in nurturing both.

His work will include managing the Biodiversity Strategy 2030, attempting to secure an agreement between States at the 2020 Conference of the Parties to the Convention on Biological Diversity and full implementation of the reformed Common Fisheries Policy. ■

Open Access Government
editorial@openaccessgovernment.org
www.openaccessgovernment.org
www.twitter.com/OpenAccessGov

The evolving workplace: How the digital economy has expanded boundaries

Cyrus Gilbert-Rolfe, EMEA MD SocialChorus explains the nature of the evolving workplace in terms of how the digital economy has expanded boundaries and driven a fundamental shift in the nature of business

The digital economy has expanded boundaries and driven a fundamental shift in the nature of business meaning the 9-5 work life has changed dramatically. It's almost unrecognisable.

The World Bank recently published its World Development Report for 2019 on The Changing Nature of Work – a study of how work is changing as a result of advances in technology. While the report addresses the impact of technological progress on the workforce – finding that life expectancy has gone up; basic health care and education are widespread, and that most people have seen their incomes rise – it also looks at the future of work and how it is being driven by the competing forces of 'AI', automation and innovation.

> "There is no doubt that companies thrive and win when their workers feel informed, valued and engaged. The technology and the devices now exist to drive employee engagement and help both the business and people who are the driving force to flourish."

Interestingly, it found recent evidence for Europe that suggests while technology replaces some workers, it also raises labour demand. Overall, the technology that replaces routine work is estimated to have created more than 23 million jobs across Europe from 1999 to 2016.

These findings coupled with the fact that the digital economy has expanded boundaries and driven a fundamental shift in the nature of business means the 9-5 work life has changed dramatically. It's almost unrecognisable. In 2018, the Office for National Statistics reported that the UK national unemployment rate had fallen to 4.1%, its lowest since 1975 and the UK gig economy has now grown to an estimated 5 million self-employed people. According to Consultancy.uk this shift correlates with a huge boom in self-employment and freelance employment, as part of a much-heralded decline of the conventional job, following the 2008 financial crisis. The professional services sector has been a major driver for growth with the number of freelance workers reaching 2 million since 2001.

These 'gig' or freelance workers are also likely to be part of the over 2.7 billion people known as 'deskless workers', spanning industries such as agriculture, education, healthcare and retail to hospitality, manufacturing, transportation and construction. And businesses appear to be embracing this new approach to resourcing and servicing their requirements. Why and how? They're adopting the technology and mobile computing platforms to reach people with the right skills, in the right place and at the right time.

How people can work hasn't just changed, it's 'who' is actually working has also evolved. There's no doubt that millennials have had a huge impact on how businesses operate, calling for greater transparency, flexibility and demanding that organisations make themselves more attractive to the workforce. And businesses are also finding a new wave of worker too, the 70+ which has increased 131% in the UK alone over the last decade thanks to pensioner poverty.

Diverse workforce

Never before have businesses faced a more diverse workforce and with it, these employees come with very specific needs and wants. The advent of social media, messaging and smartphones have made some industries, such as retail, get smart on how to capture their target audiences. People want that personalised, consumer experience to transcend into their workplace. They are no longer just a national insurance number; they are as unique as their DNA. So how do businesses go about addressing these needs?

It's an employee engagement predicament, if ever there was. Business leaders are facing a variety of challenges from the tight job market, to "fake news" and "digital water coolers" running rampant in the enterprise, to digital distractions inundating employees with information. It's never been more difficult yet critical to keep employees aligned and informed. Gallup has looked at employee engagement over the years and most recently cited that over two-thirds of employees today are classified as not engaged, costing businesses 21% less profitability on top of productivity, retention and customer engagement.

> "Interestingly, it found recent evidence for Europe that suggests while technology replaces some workers, it also raises labour demand. Overall, the technology that replaces routine work is estimated to have created more than 23 million jobs across Europe from 1999 to 2016."

The best internal communicators understand their audience and support employee engagement that drives desired business outcomes. And a more connected workforce is a catalyst for improved business results. Different employees consume content differently and with today's diverse workforce the needs are going to vary greatly. Some employees will check email regularly, others only have access to their smartphones or tablets during work, some may prefer a phone call or a notice on the company intranet. One method of communication will not be enough. Businesses need to meet employees where they are, and this includes having a plan in place in case their primary means of communication is not available.

One area where companies are continually failing is in spamming their employees and assuming that one size fits all. This observation breaks down into a few key areas. Content should be bite-sized and varied as the data from a recent SocialChorus study showed that employees use their company app for around two minutes at a time. That doesn't necessarily mean the content should be shorter, but it does need to be broken up with headlines, photos, links and other content that is easy to scan or read on smaller screens. The way in which it is presented should all be mixed up. A variety of visuals ranging from photos to infographics will help employees to grasp your communications more easily.

Cyrus Gilbert-Rolfe

There is no doubt that companies thrive and win when their workers feel informed, valued and engaged. The technology and the devices now exist to drive employee engagement and help both the business and people who are the driving force to flourish. In today's cutthroat environment businesses really can't afford to keep doing the same old newsletters and emails knowing that no-one is reading or interested. An engaged workforce is a loyal one. ■

Cyrus Gilbert-Rolfe
EMEA MD
SocialChorus
Tel: +44 (0)20 8638 5960
info@socialchorus.com
www.socialchorus.com
www.twitter.com/SocialChorus

Smarter Workplace: Does the 'artificial' in AI distract us?

PLACEmaking considers if emphasising the 'artificial' in AI distracts from the range of benefits that are there to be exploited in the Smarter Workplace

The term AI, or Artificial Intelligence, was plucked from history and adopted in 1956 to describe the processing logic of a programmable computer. It's quite marvellous that we are still using an expression coined over sixty years ago to describe the kind of 'futuristic technologies' that many of us are only just beginning to acknowledge – yet so far few of us have experienced.

But while for most of the time since then we have been happy enough to adopt a whole range of technology advances, why in the last ten or 15 years have we become increasingly cautious about the growth and development of AI? It might well be because the technologies we've experienced in the general office workplace so far haven't really made the big breakthroughs we were promised they would, and what has been delivered has made only incremental differences to our everyday lives. There has been no big bang as such, and so we've had sufficient advance warning and time to adapt, retrain or reinvent our way of working.

Whilst in some environments the prospect of working alongside AI has been embraced and is well established, what we're continually being told is AI will in some industries and sectors replace people. We haven't heard too much about the impact AI will have on the office workplace. Is the workplace immune or have we perhaps been lured in to a false sense of security because although office-related technology has unmistakably developed, on the whole the office workplace itself remains largely the same – albeit tweaked over time thanks to different generations of fashions in furniture and decoration styles.

Is Smart Working creating an opportunity for embracing emerging technologies?

Now that Smart Working is being widely acknowledged across both the private and public sectors, however, we should be poised and ready for the next wave of AI related technology-enabled change – not simply with regard to where we work but also how we work. Yet there are still barriers to embracing the real benefits of Smart Working, and some of those barriers include technology – what's available, how we should use it, how well it performs, and how we are supported when we are increasingly reliant on it.

Our recent field case studies highlight common Smart Working implementation issues. In amongst broader references to inconsistent and untargeted communications, one specific issue stands out: the lack of anyone who is able to articulate (in a language anyone in the business can understand) exactly how the technology device, hardware or software about to be implemented will actually improve a User's day-to-day working experience. Too often the purpose for the upgrade becomes muddled by the process of roll-out, and project management 'time and cost' measures dominate feedback. Targets for User improvements are rarely defined, and almost never tested or reported and so the prospect of unknown AI related technology entering the workplace can be viewed with dread.

But with the principles of Smart Working now firmly established, the opportunity should really exist to embrace the next generation of technologies that will facilitate a step change in our working processes, patterns and styles. In order to foster this culture, we need to recognise and address the challenges that prevent many from fully trusting the technology solutions already available.

But what we also need to do better is engage Users in envisaging what sort of workplace experience they want, and subsequently present better the technologies on offer so that they can be seen to meet those expectations. If we can articulate what we want in non-technical language then we have a better chance of encouraging people to use and benefit from such technology investments.

We asked a selection of Users who have already embraced Smart Working to envisage their future workplace experience, highlighting what they

think could be achieved and improved by AI.

'We are now working remotely more and more often. When we do go to our (employer's) office Building we frequently feel like a visitor – tolerated but not necessarily welcome. We want to be able to interact with the Building so that our personal preferences, needs and expectations are recognised and facilitated as much as those people based in the building full time.

'When we're working remotely, we want to use that time to concentrate on completing specific tasks or hitting deadlines. When we go into the office, we're there for a reason which includes collaborating and interacting with others, so we want the Building to actively connect us with the people who can help solve our problems and assist us with seeking out solutions. We want facilities that support our needs to be available and we want to use space and facilities that will directly help us to complete our intended tasks. We want the Building to do more than that though – we want it to facilitate our activities but also monitor our progress in achieving our planned objectives and nudge us to stay on target and avoid getting distracted'.

How could AI change that User experience?

'We want AI to support us in effectively removing repetitive, mindless and basic administrative duties, freeing up our time for tasks and interactions that are more skilled, creative, engaging and empathetic. But we also think AI could help us to solve problems or make better choices.

'For example, we want to explore systems that go beyond simple booking or scheduling tools. Perhaps what we want AI to do is not just agree to a basic request for booking travel, but to analyse the request and offer alternative responses or suggestions including options that we may be unaware of or had simply not even considered. AI should be able to adapt to and help solve the issues that we are facing, opening up alternative options for us to consider and potentially select.'

How could AI help Smart Working support services to operate more effectively?

'What we want is active problem-solving support with dynamic, adaptive help that is tailored to our individual needs rather than simply reading from a script. We need a more intelligent form of assistance that not only records that there is an issue, but analyses the context of the problem we have and provides an intelligent response.

'For example, we often get frustrated by the standard response we get when we contact support services if we've got an ICT problem, which too often is just "contact the (outsourced) Help Desk". We then have to repeat over and again what the problem is.....only for them eventually to say that we need to take the laptop in (where?) for repair!". AI should make the response more personal. As well as a first line of support to help us with common problems it should recognise our specific circumstance, offer a more appropriate response relevant to the context of our working environment. One size definitely doesn't fit all!'

The future of technology in the workplace does not lie with the adoption of AI for the sake of AI, but in using it in an intelligent way that people can recognise will assist them in their day to day duties. Rather than simply being a tool for everyday tasks, AI could - and should - be a valuable contributor to the collaborative process: facilitating an ongoing conversation between user and system that not only assists in project development but also acts as an intelligent facilitator and collaborator in achieving a valued outcome. Presented in this way, the next wave of AI-based technology should be welcomed and not feared. Not regarded as a background device that sits idly by, only stimulated into use when needed, but instead a fundamental and active part of any team and in partnership with people.

Authors: Alison White, co-founder PLACEmaking, Fintan Burke and Tom Mitchell

PLACEmaking

Alison White
Co-Founder
PLACEmaking
www.placemaking.co.uk
www.twitter.com/placemaking_uk
Facebook.com/PLACEmaking.com

Why higher apprenticeships are critical to business

Tristram Hooley, Chief Research Officer, Institute of Student Employers explains precisely why higher apprenticeships are critical to business

England has had a troubled history with vocational education. From 1563, when the Statute of Artificers first set up a national framework for apprenticeships, to the present day, the system has been through endless twists, turns and reinventions.

Despite this instability, there are a few areas of clear agreement. Firstly, that apprenticeship's structured combination of work and training are a good thing for individuals, employers and the country. Secondly, there is a need to rebalance the education system away from the academic route. This requires an increase in the status of the vocational route, which is often described as 'parity of esteem'.

Higher and degree apprenticeships

One requirement for parity of esteem is that an apprenticeship can offer access to a good career and progression. In other words, apprenticeships can't be a dead-end and should be able to offer as clear a pathway to the good life as traditional A levels and degrees.

England made a big step forwards when higher apprenticeships (levels four and five) were introduced in 2010 and degree apprenticeships (levels six and seven) in 2014. Learners can now follow an apprenticeship pathway and end up just as qualified as someone who followed the academic path.

What is more, the apprentice who has progressed to degree level will have done it without paying university fees and while building up a lot of work experience.

Higher and degree apprenticeships have been growing rapidly since their introduction and now makeup around 13% of all apprenticeship starts.

Employers are very enthusiastic about higher-level qualifications, particularly in light of the introduction of the apprenticeship levy in 2017, which requires employers to spend 0.5% of their pay bill on apprenticeships. As one employer that we talked to for our recent research on the apprenticeship system commented, "Our capacity to spend the levy at the lower end is very limited. We are a high-skill business. If we only recruited at level 3 it wouldn't drive our business forward. Degree apprentices are essential for our business."

So, the levy is incentivising employer engagement with apprenticeships, but it is only when this is coupled with high-level training opportunities that apprenticeships really become relevant to all employers.

What's the problem?

In many ways, the introduction of higher apprenticeships has been a good news story. They have increased the status of apprenticeships and provided apprentices with a progression route to high-skill careers. What is more, they have been growing steadily and have won over employers.

Institute of Student Employers (ISE) has been campaigning to support and extend higher and degree apprenticeships as part of a campaign that we launched with the publication of our report, '*Stability, transparency, flexibility and employer ownership: Employer recommendations for improving the apprenticeship system*.

Not everyone agrees with us. Some commentators have been arguing that higher apprenticeships are too expensive and that they move resources away from low skill workers. However, we think that this misses the point and frames the debate on apprenticeships in an unhelpful way.

Tristram Hooley, Chief Research Officer

Firstly, employers are not very sympathetic to the government crying poverty. Employers have recently injected a massive new funding stream into the apprenticeship system through the apprenticeship levy.

Secondly, there is a need to move away from seeing the apprenticeship system as a way to address social injustice and failures in the educational system. These are important secondary aims, but the primary purpose of the system should be about developing the skills that businesses need.

Businesses are telling us that they need higher apprenticeships and so it would be dangerous for the government to try and limit this.

What needs to be done?

ISE believes that the government should reaffirm its commitment to higher and degree level apprenticeship and resist short-sighted calls to restrict access to these apprenticeships on the basis of prior qualifications.

The specific point about higher apprenticeships is connected to a broader vision of how the apprenticeship system should develop. We have outlined four principles that we believe should guide any future revisions and reforms of the system:

- **Stability:** Business thrives in a stable environment. The government should ensure that the apprenticeship system remains as stable as possible and that new innovations are introduced carefully and with employer consultation.

- **Transparency:** The apprenticeship system, and particularly decisions about funding, needs to be made more transparent.

- **Flexibility:** Systems need to be designed with an understanding of the operational requirements of running a business.

- **Employer ownership:** The government rightly committed to the principle of employer ownership of the system when it was launched. It is important that this principle guides all future thinking about the system. ■

You can follow the ISE's campaign to #fixapprenticeships @IoSEorg

Tristram Hooley
Chief Research Officer
Institute of Student Employers (ISE)
Tel: +44 (0)20 7033 2465
Tristram@ise.org.uk
https://ise.org.uk/
www.twitter.com/IoSEorg

Laying the foundations for a successful degree apprenticeship programme

Alasdair Poole, Apprenticeships Manager at Ashridge Executive Education details the importance of laying the foundations for a successful degree apprenticeship programme

The arrival of degree apprenticeships has revolutionised learning for public sector leaders – offering access to Masters-level qualifications that have been out of reach for many during times of austerity.

A growing number of organisations in government and across the health sector are now looking at how they can use their Apprenticeship Levy to fund these high-quality management development programmes, which are designed to build the skills and behaviours executives need to lead their people effectively in challenging times.

So, what are the key advantages of going down a degree apprenticeship route – and what do organisations need to do to set their programmes up for success?

A pragmatic approach

Ashridge Executive Education is a key player in the degree apprenticeship market and is leading the way with the development of three, highly pragmatic programmes which aim to raise standards of management practice and equip leaders with the agility and resilience needed to succeed in the new world of work.

The Level 6 Degree Apprenticeship is designed to boost the skills and performance of junior and emerging managers, by providing them with the tools and knowledge to make an immediate difference in the workplace. The three-and-a-half-year programme results in the award of a BA in Business and Management.

There are two Level 7 programmes. The Executive Masters in Leadership and Management is aimed at fast track, middle and established managers who want to stretch themselves using a flexible, self-directed learning approach. The two-year programme covers a range of subjects, from innovation to digital transformation, and places a strong emphasis throughout on personal impact and relational skills.

The more advanced Executive MBA is targeted at experienced managers and functional specialists who want to accelerate their progress into strategic management and leadership roles. This Level 7 qualification is part-funded by the levy, with the employer paying a top-up fee.

The appeal for organisations is the practical, grounded-in-reality approach taken during the programmes. Participants draw on live workplace scenarios as part of their learning, giving them the opportunity to develop fresh perspectives on some of the tough challenges they are facing.

There is also a major, supervised project at the end of programmes, which focuses on an area of organisational challenge, chosen together with the employer. This not only helps individuals deepen their understanding of the organisation they are working for, but also provides the employer with a valuable piece of internal consultancy it can build on.

> "On one recent programme, for example, Ashridge actually worked directly with learners to co-create content for a particular module, resulting in a fresh, stimulating learning experience that was directly relevant to the organisation."

Making sure the right foundations are in place is, however, fundamental to the success of any degree apprenticeship programme. Ashridge's experience in working with organisations going through the first tranche of apprenticeship programmes suggests the following issues are key:

Senior level endorsement

The employer is an important stakeholder in the degree apprenticeship process, championing participants through their studies and supporting them in applying their new-found knowledge and skills back in the workplace. This means that securing commitment to the programme at the highest level is critical. HR and L&D professionals will need to convince senior management of the potential for degree apprenticeships to help the organisation get future-fit – developing

the skills it will need to thrive in a constantly changing, digitally-driven environment and helping to attract and retain the best talent.

Clear communication

Misconceptions about apprenticeships still abound and organisations may find they have a certain amount of groundwork to do in explaining how they work at a higher level. A planned internal communications campaign can help to generate enthusiasm and address any concerns that may exist among potential participants. Ideas might include briefings for managers, placing articles on internal communication platforms or drawing up a list of FAQs. Ashridge has supported client organisations by running webinars for potential learners, explaining the degree apprenticeship process and giving participants the opportunity to ask questions.

Finding the right participants

It's important not to assume that degree apprenticeships will work for everyone. For some individuals, an open programme or being part of a customer group of senior executives can be a better solution. A clear 'recruitment' process will help to ensure the right people are being directed to the right kind of learning. Some organisations have tackled this by inviting expressions of interest from employees, backed up by a short personal statement about why they feel this particular study route will work for them. Offering one-to-one consultations for learners who are undecided or want more information can also be helpful. Ashridge supports organisations with this process, helping them to sift applications if required and advising on alternative options where appropriate.

Integrating degree apprenticeships

Degree apprenticeships work best when they are seen as part of the bigger L&D picture, rather than a stand-alone development intervention. Organisations need to think strategically about what skills they will need in the future and how a higher level apprenticeship can help to build them. They need to consider what kind of leadership roles will emerge in the new world of work and how degree apprenticeships could prepare employees to fill them. Organisations who take this wider, longer-term view are more likely to reap the benefits of the programme and get a return on their investment.

Working in partnership

Finding a provider who fits with the company culture and approach and is willing to develop a close working relationship is critical to the success of a degree apprenticeship programme. A good provider will take a collaborative, consultative approach, working closely with the organisation to design learning that is job specific and immediately transferrable back in the workplace.

On one recent programme, for example, Ashridge actually worked directly with learners to co-create content for a particular module, resulting in a fresh, stimulating learning experience that was directly relevant to the organisation. Finding a provider who is able to be flexible on delivery method is also key, to ensure that managers are able to successfully integrate their studies with demanding day jobs.

ASHRIDGE
EXECUTIVE EDUCATION
HULT

Alasdair Poole
Apprenticeships Manager
Ashridge Executive Education
Tel: +44 (0)1442 841 031
Alasdair.poole@ashridge.hult.edu
www.hult.edu/en/executive-education

Coaching and mentoring: A style of management

Dessy Ohanians, Managing Director of Corporate and Certificate Programmes at the London School of Business and Finance – Executive Education argues that coaching and mentoring are a style of management that has become more prevalent during the last few years

Coaching and mentoring as a management style has become more prevalent in the last few years and not without reason. Companies and leaders are realising the benefits of adopting this style not just for the organisation but for the individuals being coached as well.

The growing appreciation for professional coaching has turned this resource into an industry with an estimated worth of $2 billion globally. It is reported that there are over 60,000 professional coaches practising around the world today. However, you do not necessarily need the services of a professional coach in order to incorporate coaching techniques into your leadership style.

Basic coaching techniques used on a daily basis have a profound effect on individual performance and a company's financial results. The International Coaching Federation reports that 80% of people coached at work reported increased self-confidence. 70% recorded improved performance which is why it is no wonder companies are encouraging coaching as a leadership practice.

To understand this, it is important to clarify the difference between coaching and mentoring. The first difference is in time scale; coaching tends to be short-term whilst mentoring is a longer-term process. Coaching tends to focus on specific skills and is more operational and task-oriented. By contrast, mentoring tends to focus on relationship building and is more development driven. In addition, the immediate manager of the person being coached plays a crucial part in the coaching process while in mentoring they tend to be involved but in a more indirect way.

Coaching takes time, requiring more input than just giving instructions to your team. Time must be dedicated to the coaching activity, whether it is done through a dedicated coaching session or incorporated into the management style and permeated through day-to-day activities. Time must then be set aside for team members to go through the thought-process to absorb the new points of view and conclusions reached. Finally, time must be taken away from leaders attending to other strategic priorities and their own responsibilities.

The cost could be another issue if external coaches are used for this activity.

"Basic coaching techniques used on a daily basis have a profound effect on individual performance and a company's financial results. The International Coaching Federation reports that 80% of people coached at work reported increased self-confidence. 70% recorded improved performance which is why it is no wonder companies are encouraging coaching as a leadership practice."

Despite these short-term disadvantages, the long-term benefits could vastly outweigh the sacrifices. The benefits of coaching begin with the individual being coached. As the objective of coaching is to guide people to reach their own conclusions and find their own solutions, each employee will gradually build their self-confidence to the point of independence. Employees will depend less on their managers, thus freeing up the manager's time to deal with their other duties.

Coaching not only helps improve the quality of learning but the employees gain skills for life that contribute

Dessy Ohanians, Managing Director of Corporate and Certificate Programmes

towards their overall personal and professional development.

The benefits for the organisation are even more measurable and tangible. The modern organisation has realised that the real value of their operations is not solely obtained through their tangible assets, but the people employed and the knowledge, ideas and inspiration that can be garnered from them. A company's success is measured not just through revenue and profit, but also through factors such as customer satisfaction which can only be achieved when employees possess the right skills and motivations. Coached employees have demonstrated greater creativity as they are able to produce their own solutions, whilst greater employee engagement results in lower staff turnover and improved productivity. Companies, where leaders use coaching-style engagement, have also reported lower development and training costs alongside a greater skilled workforce and better use of people, skills and resources.

Leadership skills are typically associated with grand strategic decisions but, in reality, building relationships is a core skill of great leaders. If you want to start implementing some coaching techniques, here are some practical steps to get you started:

- **Start a coaching conversation**
  Put on your 'coaching hat' and make clear you are not talking to them as a leader from whom they should expect directions and instructions but that you are entering a coaching mode. That will set the right expectations and the learning can begin.

- **Allow for self-evaluation**
  The opportunity to identify and correct one's own errors is valuable as it presents the employee with their own learning curve. Self-evaluation thus enables them to see how they've developed and this skill is vital over time.

- **Give feedback**
  A primary aspect of good coaching is providing feedback. Well-delivered and timely feedback (allowing for self-evaluation) provides people with a personable summary of ways to improve, praising positives when achieved and advising on how to correct errors. The famous "sandwich technique" of giving positive-negative-positive feedback is proven to not work particularly well, so avoid this.

- **Build rapport**
  Coaching and knowing what questions to ask to create a personal connection can allow for a rapport to build quicker and more effectively. It will help employees improve their own rapport building skills.

- **Adapt**
  All employees are different and their requirements for coaching will vary accordingly. Be ready to adapt your techniques in all the above areas to best connect with them. ■

Dessy Ohanians
Managing Director of Corporate and Certificate Programmes
London School of Business and Finance – Executive Education
www.lsbf.org.uk/programmes/executive
www.twitter.com/LSBF

What's the difference between chatting and coaching?

Karen Dean from Diabolo Limited and me:my™coach and Sam Humphrey from Grit Limited explore the all-important difference between chatting and coaching

We love a good chat. The opportunity to blow off about someone, the chance to get something off our chest, the freedom to speak our mind. These conversations happen between partners, friends, family and colleagues. We may have a preferred individual to chat with. We may find ourselves telling the story of what happened over and over again, seeking understanding and validation from anyone who will listen. During a chat, it is common for the listener to try and show empathy, by quickly sharing what similarly happened to them. This can feel like a hijack and be frustrating. On the other hand, it can feel comforting that "I am not the only one going through this." There is always a place for a good chat.

Chatting enables us to make a connection with another human being. Finding a bond with others helps us thrive, not just survive. Talking combats loneliness and we feel valued and included. Neurochemistry is presenting evidence of the hormones which are stimulated when we can talk in a trusting, transparent way.

A coaching conversation is very different from a chat in particular ways. There are conditions which need to be met to demonstrate coaching competencies. These are now specified by credentialing bodies, such as the International Coach Federation (ICF) or European Coaching and Mentoring Council (EMCC).

There are hundreds of definitions of coaching. One which has endured is offered by Miles Downey. One of the early influencers of professional coaching, he defines coaching as the "art of facilitating the performance, learning and development of another." Paying attention to each of the words will expand the meaning and intention, illustrating the essence of a coaching conversation.

Art – Coaching is an art in that although there is likely to be a process being followed, there is something uniquely co-created by both parties in the moment as they bring their ways of being into the mix.

Facilitating – Is important as the coach is there to support and challenge the client to think in new ways, finding their own solutions. Deep listening is key. In Nancy Klein's book, *Time to Think*, she describes how to create a safe environment enabling access to high-quality thinking by being fully present for, and listening fully to, the client. In a coaching conversation, much time is spent discussing and agreeing on what permissions exist in the coaching relationship. These permissions would typically cover things like confidentiality, levels of challenge and feedback to others. In exploring permissions, the coach and client begin to build trust which is vital for achieving outcomes. In a chat, there is no such agreement or permission; the conversation will arrive unannounced and without agency.

> "The coach might be asked to keep the client- focused, could be invited to challenge, may be asked to give them time to reflect or to ensure they maintain momentum. The coach needs to be open to their client guiding them to be the best coach they can be."

Performance – This comes as a consequence of coaching, performance is enhanced in its delivery, speed, quality, skill, or by easing a transition. Performance necessitates a goal to be set. Chats are often aimless, meandering until the subject matter surfaces. Whilst a good outcome may result from a chat, it is rarely planned.

Learning – This is stimulated by the coach offering feedback and observations. This expands the client's awareness, enabling a deeper understanding of their patterns and preferences. Insight results in choices being made which have not previously been apparent or available.

Development – In coaching, this is about growing and integrating new knowledge and taking fresh courses of action, deepening the sense of autonomy and individuality. We can challenge our beliefs, define our

values and craft our sense of self. Coaching accelerates development.

Another – The whole conversation is about the other, the client. Coaching tends not to be a space where the coach shares their stories. The coach acknowledges what the client seems to be experiencing, such as frustration, anger, sadness or challenge. Coaching is all about the client and the goals or outcomes they have chosen. Coaching is different from mentoring. Mentoring embodies the notion that "I've walked this path before and I'm giving you the benefit of my knowledge and experience". Ideas are offered and suggestions made.

The role of the coach and the manner in which this plays out is defined by the client. The coach might be asked to keep the client-focused, could be invited to challenge, may be asked to give them time to reflect or to ensure they maintain momentum. The coach needs to be open to their client guiding them to be the best coach they can be. In a chat, there are few such 'rules of engagement', both parties operate in silent assumption as to their role and purpose in a chat.

A coaching conversation focuses on the future. Having an objective makes measurement possible. Coaching conversations should add value to the client, create change or movement which has a tangible or visceral result. As many coaching conversations are a funded service, they demand a return on investment or a return on expectation. The funding may take the form of an external coach's fees or an internal coach's time, either way, there is a cost attached. This is not so for a chat. We can shoot the breeze for free with anyone we want and for as long as we want – there is no expectation that a chat should fundamentally change anything, long term.

When moving forward really matters, a coach or manager using a coaching style will offer a more impactful intervention. The conditions written here will guide and refresh the ground rules for effective coaching and help keep them separate from juicy chats.

Coaching Stories: Flowing and Falling of Being a Coach *by Karen Dean and Sam Humphrey was published by Routledge, worldwide, in February 2019.*

GRIT

me:my™coach

Diabolo

Karen Dean MCC
Managing Director, Executive Coach and Originator
Diabolo Limited and me:my™coach.
Tel: +44 (0)1158 450 137
Mobile: +44 (0)7802 748 793
karen.dean@diabololimited.com
www.diabololimited.com
www.memycoach.com
www.twitter.com/memybrands

Sam Humphrey
Managing Director, Executive Coach
Grit Limited
Tel: +44 (0)7767 417 450
sam@grit.co.uk

Cycle to Work Scheme: Promoting health for people and the environment

Rachel White, Head of Public Affairs, Sustrans shares her views on how the Cycle to Work Scheme is promoting health for people and our environment

The Cycle to Work Scheme was introduced in 1999 with the aim of improving air quality and promoting healthier journeys to work. It is a salary sacrifice scheme in which employees can usually save between 32%-42% on the cost of a cycle and associated accessories, such as a helmet or mudguard.

Many employers offer the Cycle to Work Scheme and it's quite a simple set up: you pay for the cycle and the accessories directly from your gross salary prior to tax and national insurance being deducted. As tax and national insurance are based on your gross salary, which is now reduced by the cost of the cycle, the amount you pay in national insurance and tax is reduced and a saving is made. It is, therefore, a very popular and appealing concept.

Employees 'hire' the cycle for a year, paying the cost of the cycle back over twelve monthly instalments. At the end of the year, you can choose to own the bike immediately or continue to hire it for an additional three years at no extra cost but with additional savings, by paying a refundable 3-7% deposit of the money you spent on the cycle and accessories. It doesn't matter if you change employer in this period – the cycle comes with you.

Making cycling more accessible for everyone

The best bit is that the government has just made the scheme better and more accessible to more people by clarifying guidance which makes it easier for employers to provide cycles and equipment to a value greater than £1,000 with a top value removed altogether. Having a top value of £1,000 was always problematic if the government is serious about encouraging more people to cycle to work instead of commuting by car and hitting their doubling cycling target by 2025.

Many disabled people find it easier to cycle than walk but an adapted cycle rarely costs under £1,000 – often it costs significantly more, meaning up until now, anyone requiring an adapted cycle could not use the scheme. E-bikes are also more expensive and are better for older or less fit people who want to start cycling. E-bikes prevent two of the big reasons people give for not cycling: 'it's too hilly' or 'I don't want to get too sweaty as my work doesn't have showers.' The motors kick in to give you an extra hand up those hills preventing that extra perspiration.

> "Glasgow University also found that regularly cycling the commute to work reduced your chances of cancer by 45% and your chances of getting heart disease by 46%. In addition, Sustrans has found that people who cycle regularly take half as many sick days than those that don't which saves employers and the wider economy a huge amount of money in efficiency gains."

It's not a complete panacea. By its very nature, the scheme is only available to people who work, which cuts out a huge number of society who would benefit from owning a bike and is something the government should look at further.

Why it has never been more important to get more people cycling to work

A cycling and walking charity would say that it is vital to get more people cycling to work but the truth is that this has never been more important than it is now. For the first time, we are seeing life expectancy decreasing through inactive lifestyles and poor diet.

Physical inactivity is costing the NHS an estimated £1 billion every year. Sustrans' Bike Life reports, surveyed 7,700 people across seven major cities in the UK. They


Rachel White

showed that in 2017 across these UK cities, 123 million bike trips occurred. This contributed to savings to the NHS of £8 million annually, equivalent to the average salary of 343 nurses. With cycling to work physical activity is incorporated into your daily routine rather than forcing yourself down the gym each day which means you are far more likely to keep it up in the long term.

Glasgow University also found that regularly cycling the commute to work reduced your chances of cancer by 45% and your chances of getting heart disease by 46%. In addition, Sustrans has found that people who cycle regularly take half as many sick days than those that don't which saves employers and the wider economy a huge amount of money in efficiency gains.

We also face a climate crisis and poor air quality of which motorised transport is a huge contributor so getting more people out of cars and cycling to work has untapped environmental benefits. For example, congestion cost the UK nearly £8 billion in 2018 from delayed productivity and costs to the environment. Cycling reduces congestion. A typical road-lane can carry seven times as many cycles per hour as cars. Less congestion means better air quality but it also helps out those who have no alternative but to drive. Therefore, the 'Cycle to Work Scheme' is a win for everyone whether you choose to use it or not.

> "Physical inactivity is costing the NHS an estimated £1 billion every year. Sustrans' Bike Life reports, surveyed 7,700 people across seven major cities in the UK. They showed that in 2017 across these UK cities, 123 million bike trips occurred. This contributed to savings to the NHS of £8 million annually, equivalent to the average salary of 343 nurses."

But let's make no mistake. Now is the time to use it and employers need to make it as appealing as possible by lifting the £1,000 cap and providing proper cycle facilities, such as safe bike storage and showers. We also need to make the wider environment safer and more appealing so that more people chose to cycle and for this, governments at all levels must invest in a protected network of cycling infrastructure that gets people from their doors to the office. ■

Rachel White
Head of Public Affairs
Sustrans
Tel: +44 (0)117 926 8893
reception@sustrans.org.uk
www.sustrans.org.uk
www.twitter.com/sustrans

Turning employee commutes green

Joanna Flint, from Green Commute Initiative, illustrates how introducing a cycle to work scheme will help your organisation's efforts to improve its sustainability in the workplace

Last month, the Transport Committee issued a report which showed that increasing levels of walking and cycling will cut traffic congestion, air pollution and improve health.

However, the report criticised the Government's current Cycling and Walking Investment Strategy as "not ambitious enough" and called for a strategy to enable people to get out of their cars and walk or cycle for short journeys, or part of a longer journey. Government investment in active travel at just 1.5% is tiny when compared with spending in other areas of transport.

Road transport is the single biggest contributor to poor air quality and is responsible for 80% of roadside nitrogen dioxide concentration. Poor air quality is a killer, causing diseases such as stroke, heart disease, lung cancer and respiratory infections. The UK has one of the worst asthma death rates in Europe and there were a record number of deaths from the condition in 2017.

Children are particularly vulnerable from air pollution with dirty air stunting their lung development and leading to poor health later in life. A new study by King's College London will monitor air quality exposure of 250 children on their way to school. The study will use backpacks which will measure particulate matter and nitrogen dioxide levels. The study aims to achieve better understanding of which pollutants are the most harmful and where they are coming from, helping to support effective improvements in public health.

Under plans to cut congestion and reduce pollution, a Workplace Parking Levy is being considered by at least 10 councils and is already in effect in Nottingham city centre. The charges affect businesses with more than 10 parking spaces. Since 2012, Nottingham City Council has raised £53.7 million from the levy which has been used to improve Nottingham's tram network.

Nationally, over 30% of all emissions comes from transport; it needs to be just 12% by 2030. However, the number of vehicles on the road increases every year. Surprisingly, a large percentage of short car journeys are less than two miles. Two miles is approximately a 40-minute walk and considerably less on a bicycle. On an E-bike, it's even less at under 10 minutes. It's time to ditch the car and switch to sustainable alternatives, such as E-bikes.

It's become clear that cycling has an important role to play in the health of the nation and your organisation can encourage its employees to use active travel for their commute to work.

Cycle to work will make a difference

The Government introduced the Cycle to Work Scheme in 1999 with the aim to get more people cycling to work. Scheme objectives include cheaper travel, better health, increased productivity, lower congestion and better air quality.

Green Commute Initiative (GCI) is a pioneer in the cycle to work industry and was the first to offer a scheme with no limits plus no exit fees. Whereas traditional schemes were limited to £1,000, GCI developed an FCA & HMRC compliant model without a spending cap.

No limit means every type of bicycle is available; traditional pedal, electric bike, cargo bike and specialist cycles and trikes for those with mobility issues. Employees can make savings of up to 47% with employers saving 13.8% on reduced NICs.

GCI has a Framework agreement in place which has been used by other public sector organisations. Current clients include councils, NHS trusts, universities and police forces.

GCI also has a very important safeguard which other providers don't offer. With the GCI model, the C2W provider owns the bikes from the outset. In the event of the provider failing financially, a liquidator could recover the bikes for the benefit of creditors.

However, as a not-for-profit social enterprise whose constitution prevents it from taking on debt, GCI will never have any creditors or become insolvent. So unlike other C2W providers, the bikes supplied will always end up with the employee. GCI is the only cycle-to-work provider to offer this vital and important safeguard.

Originally, GCI was set-up to enable more people to get expensive electric bikes (E-bikes) on the Government's Cycle to Work scheme. GCI is passionate about E-bikes, seeing them as the future of commuter travel.

E-bikes – enabling active travel

E-bikes are perfect for people new or returning to cycling and for those who want to have a quicker and easier commute to work. The bikes bypass many commuter issues whilst helping to improve individual health and fitness, as well as the quality of air that surrounds us all.

> "It is clear that cycling has an important role to play in the health of the nation and your organisation can encourage its employees to use active travel for their commute to work."

The battery assistance kicks in when required which means hills and distances are no longer sweat-inducing obstacles. Employees arrive at work on time, feeling happier and healthier. They can wear their business attire without the need to shower. They'll probably become more effective in their workplace. In short, everyone wins with an E-bike.

Contrary to popular belief, E-biking is not cheating. Recent research has shown that even on E-bikes, physical exertion is needed 95% of the time. The study recorded oxygen consumption and revealed that E-bike use placed users at 8.5 times more active over resting, while pedal power alone registered at 10.9 times more active, a closer margin than previously assumed. It was also found that pedal cycle users utilised 58% of lung capacity, with 51% for e-assistance.

NICE guidelines for workplaces

In addition to the Transport Committee's call for action, NICE recently released guidelines on encouraging activity in the general population. The guidelines were issued following multiple studies which have shown that obesity and some chronic conditions can be managed by increasing levels of physical activity.

One specific area targeted by the draft guidelines is the recommendation that employers should have physical activity programmes in place to encourage employees to move more when travelling to/from work. Increasing physical activity levels should lead to a reduction in the prevalence of some illnesses and medical conditions, as well as improving staff morale.

One easy step that employers can take to meet these new requirements is to encourage employees to actively travel to/from the workplace, which includes using a cycle-to-work scheme.

Green Commute Initiative

Joanna Flint
Marketing Manager
Green Commute Initiative
Tel: +44 (0)20 3740 1836
info@greencommuteinitiative.uk
www.greencommuteinitiative.uk
www.twitter.com/greencommuteuk

Challenges and opportunities for the European transport sector

Director-General of DG Move of the European Commission, Henrik Hololei, outlines the challenges and opportunities for the European transport sector, including climate change, as well as research and innovation

The analogy may have been over-used, but never has it been truer. Transport is today at a crossroads. Transport activity has never been so high and it continues to rise. By 2050, passenger transport is expected to grow by 42% and freight transport by 60%. At the same time, our transport network has never experienced so much pressure. A capacity crunch is already evident for certain transport modes and unless we act, the squeeze will get tighter. For instance, if capacity remains as it is, it is estimated that by 2040, annual demand for flights in Europe will outnumber the number of possible flights by 1.5 million. This would mean 160 million passengers being unable to fly.

Alongside limited capacity, the challenge posed by climate change has become a key challenge for the transport sector. We need to step up our efforts to ensure sustainable, energy-efficient and safe mobility. At the same time, we need to take advantage of the opportunities offered by a changing transport landscape, in which digitalisation, big data and the collaborative economy are all playing a far greater role. These changes are profoundly affecting the way people move, but also the way we, stakeholders and policymakers, are making sure that our regulatory environment is fit for purpose.

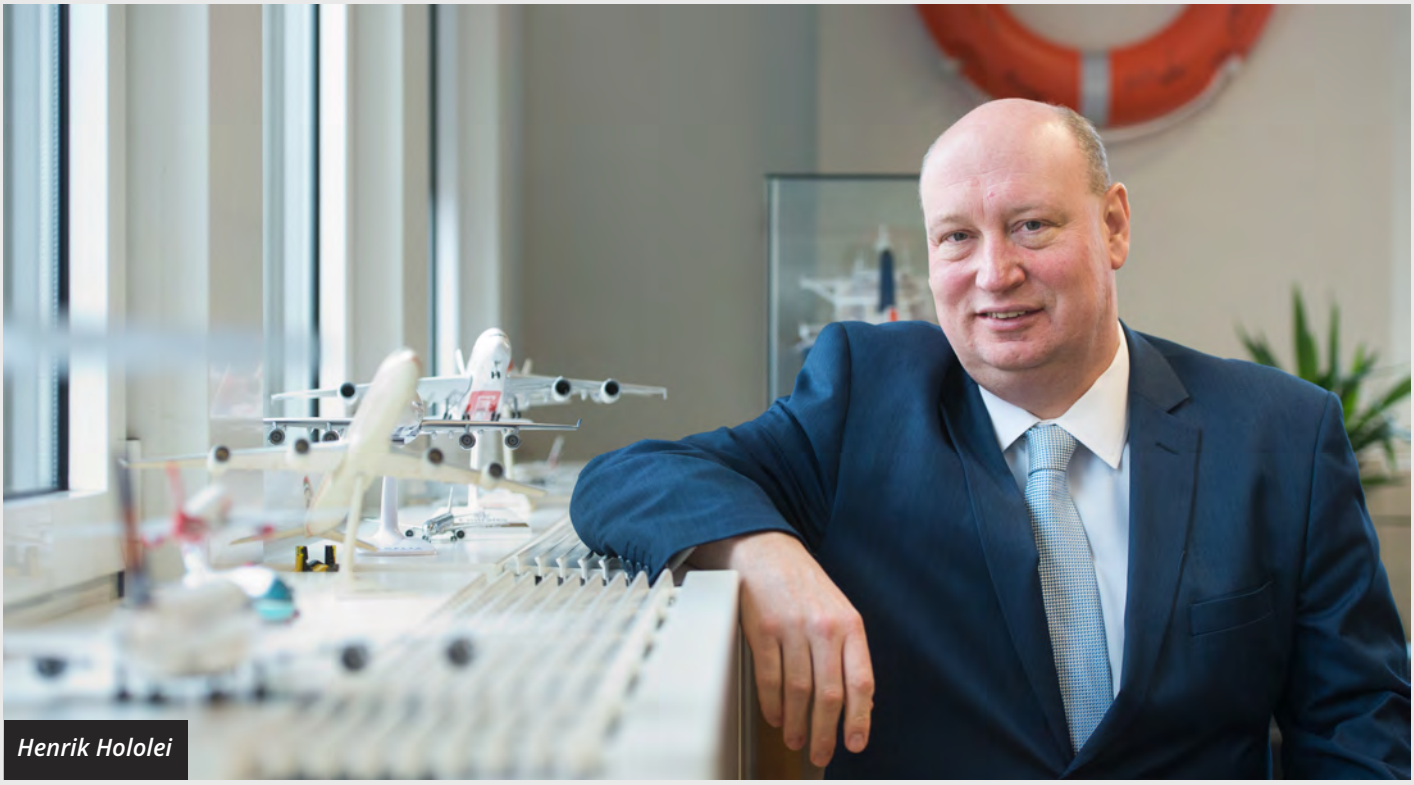
To make the most of these evolutions, it is clear that we need research and innovation. It makes good sense to have the Commission's research policy inextricably linked with its transport policy. Whether we are seeking to make transport more sustainable, more efficient, safer or more automated – progress towards all of these objectives is possible through European Union (EU)-funded research.

The European Commission cannot be the only source of transport research finance, as industry and the Member States have equally significant roles to play. Nevertheless, the Commission can and does add value by helping to fund projects that might otherwise be too costly, or too wide in scope for an individual country or industry to finance or organise.

> "Research spending also helps to keep the EU's transport industry at the forefront of global technological development. The current seven-year research programme – Horizon 2020 – expires next year. The new programme – Horizon Europe – covering the period 2021-2027, is intended to take a more holistic approach. This is achieved through an integrated approach targeting climate, energy and mobility."

I would like to highlight two partnerships with industry of which I am particularly proud – the Single European Sky Joint Undertaking (SESAR) in aviation and Shift2Rail in rail transport. SESAR is helping to modernise European air traffic management through projects that define, develop and deliver new or improved technologies and procedures. The research links directly to the EU aviation policy objectives of reducing congestion in European airspace and, in so doing, cutting emissions from aircraft. Shift2Rail, for its part, is the first European rail initiative to seek focused research, innovation and market-driven solutions and to accelerate the integration of new and advanced technologies into innovative rail product solutions.

Transport research should not be considered in isolation. It is in everyone's interests to link transport research with other EU programmes, in order to ensure that practical results can be deployed. We are delivering this through the Connecting Europe Facility, which is, for example, currently co-funding the development of a network of hydrogen fuelling stations for cars, building



Henrik Hololei

on the considerable EU research work conducted on hydrogen fuel cells.

Research spending also helps to keep the EU's transport industry at the forefront of global technological development. The current seven-year research programme – Horizon 2020 – expires next year. The new programme – Horizon Europe – covering the period 2021-2027, is intended to take a more holistic approach. This is achieved through an integrated approach targeting climate, energy and mobility. The three areas share considerable research and innovation needs and working together on a common research programme will lead to significant benefits. As an example, using and developing new technologies to improve the management and efficiency of the urban environment – so-called 'smart cities' – will address not only mobility in urban areas but also energy and climate issues.

When reflecting on research, thoughts inevitably drift towards exciting new inventions. However, we must not forget that innovation – whether designed to encourage a modal shift, understand users' views on automated vehicles, or make transport logistics more efficient – is also about understanding user behaviour. It is my firm belief that investment in behavioural science is necessary if we want to be able to put in place the technical solutions developed by our world-class researchers.

As the EU moves on from the crossroads at which it finds itself today, embracing the challenges and opportunities ahead, we must never forget that transport and mobility are central to the lives of all EU citizens – those living large cities or in the countryside, whether young or old. This dependency is two-fold: not only do we all have our own mobility needs; transport is also the lifeblood of the economy. By extension, research into transport has the potential to benefit a huge number, if not every single EU citizen.

The start of a new Commission provides an opportunity to review political priorities and to adjust them to an ever-changing world. Investing in research and innovation is the best guarantee that solutions will always be found to our greatest challenges. ■

Henrik Hololei
Director-General
DG Move of the European Commission
Tel: +32 2 299 11 11
move-infos@ec.europa.eu
https://ec.europa.eu/info/departments/mobility-and-transport_en
www.twitter.com/transport_eu

TRA VISIONS 2020: Strengthening European transport research

Alistair Greig and Matina Loukea, Project Partners at TRA VISIONS 2020 explain the importance of strengthening the European transport research

Transport is a cornerstone of European integration and is strongly connected to the promotion of economic growth and it is a sector that concerns us all as it affects the everyday lives of all European Union (EU) citizens and companies. EU transport policy of the 21st century must address the challenges the sector is facing, by proposing solutions that minimise negative effects, as well as revealing and promoting all available potentials for transport to further enhance its contribution to growth and jobs in the EU.

TRA VISIONS 2018 Senior Researcher Competition winners with competition organisers

"The European Transportation sector is at a crossroads. We need to ensure that it remains competitive and provides innovative and sustainable transport solutions."

TRA VISIONS Competitions have in recent years, become an institution aiming at precisely this; to enhance the competitiveness of the EU Transportation sector by achieving the development and wider dissemination of a wealth of innovative ideas, essential for the competitiveness of the European transport industry and also necessary for addressing current and future mobility challenges related to energy, connected and automated vehicles, safety and security, human capital and other key trends and issues.

The concept of the TRA VISIONS projects, which are being successfully implemented since 2014 in close relation to the respective TRA Conferences, is to organise two competitions for Transport Research Awards that are announced during a dedicated ceremony at the TRA Conferences, with the participation of representatives of the whole transport community, namely:

- A competition for young researchers with the goal to stimulate the interest among young researchers/students in the field of sustainable transport.
- A competition for senior researchers based on results from EU-funded projects.

The competitions of TRA VISIONS 2020 have five modes of transport; road, rail, waterborne, air and also cross-modality. The main objective is to continue and enhance the success of the previous TRA VISIONS competitions by achieving the following:

For the young researchers:

- To nurture the best transport researchers in Europe;
- To promote the alignment of their interests with those of transport industry stakeholders.

For the senior researchers:

- To promote and acknowledge the leaders in generating impactful research in transport in the EU.

Project Insights

Funding

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Contact

George Smyrnakis
Project Coordinator
info@travisions.eu
https://www.travisions.eu/

Consortium partners

WEGEMT, the Netherlands; Balance Technology Consulting GmbH, Germany; Deepblue SRL, Italy; Centre for Research & Technology HELLAS, Greece; VTI – Swedish National Road and Transport Research Institute, Sweden; University College London, UK; VTT Technical Research Centre of Finland Ltd., Finland; FEHRL – Forum of European National Highway Research Laboratories, Belgium and the European Conference of Transport Research Institutes, Belgium.

Senior Researchers Competition

The Transport Research Arena (TRA) 2020 Conference will be the fourth time that the Senior Researcher Competition is run. The TRA VISIONS Senior Researcher Competition acts as a showcase for the very best EU-funded research and aims to recognise the current and future leaders in the field, as it recognises and celebrates leading researchers who are or have recently been, contributing to transport-related EU-funded projects.

The Senior Researchers Competition concept is to have an excellence award for leading transport researchers engaged with EU-funded projects, who can demonstrate proven impacts in their field. This competition provides a platform that facilitates:

- Efficient dissemination of knowledge and results from innovation and/or research projects in the transport sector;
- The promotion of future synergies and;
- Further development of pioneering ideas in line with the strategic objectives of the TRA stakeholders.

Both TRA VISIONS competitions and project final results increase European competitive advantage, while it has been proved that they inspire the research community to propose innovative projects and the industry to adopt these.

Click here to find out more about the Senior Researcher Competition.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no. 824293.

George Smyrnakis
Project Coordinator
TRA VISIONS 2020
info@travisions.eu
www.travisions.eu

Women in transport: Reducing inequalities in smart mobility in Europe

Andree Woodcock, a Professor from Coventry University, tells us what we need to know about the H2020 TInnGO (Transport Innovation Gender Observatory) project that concerns the role of women in transport and the need to reduce inequalities in smart mobility

The H2020 TInnGO (**T**ransport **Inn**ovation **G**ender **O**bservatory) project, funded by the European Commission, aims to promote a sustainable game change in European transport by creating a new observatory, conceived as a one-stop-shop for analysis and solutions on the inequalities women face in the transport sector. It takes a three-pronged approach looking at gender and diversity issues in transport usage, employment and education.

Why is this needed?

It has long been recognised that women (and other groups) are significantly marginalised in transport. Without research in this area, the transport revolution produced by smart mobility will continue to exclude women and 'disadvantaged' groups (e.g. the elderly, those from lower-income backgrounds, with mobility, cognitive, sensory and communication difficulties). Commuting journeys are privileged by transport systems, over those related to home and social and healthcare. The complex, multilegged journeys by women and those in lower socio-economic groups are not modelled; therefore, future systems will perpetuate the same inequalities. Recent analysis conducted by TInnGO shows that around 70% of the transport workforce are male and since 1945, only 7% of the transport ministers in TInnGO countries have been female. Gendered and non-inclusive discourses are already being used to promote smart mobility solutions, despite the fact that women most use and support sustainable transport. Clearly, this situation needs to be urgently addressed if the smart city agenda is to fulfil its promises of improving the quality of life for all people.

TInnGO will address this through:

1. The creation of a **Pan European observatory** for gender smart transport innovation in the smart mobility sector. This will provide a nexus for data collection, analysis and dissemination of gender mainstreaming tools and open innovation. The observatory will collect existing resources to become the reference portal for those wishing to address gender and diversity-sensitive smart mobility. It will freely provide best practices, case studies, guidelines, tools, methodologies, training, policy documents and videos. Specific sections will allow users to participate in open innovation and share content, insights and data for collaboration.

2. The central observatory will be fed by **10 national hubs and laboratories** (Baltic States, Italy, Greece, Norway/Sweden, UK, France, Romania, Germany, Spain and Portugal), each specialising in a local issue relating to gender and inclusivity (e.g. safety, minority groups and entrepreneurship). The hubs will:

   a. Use project outputs (such as gender action plans and gender mainstreaming tools) to address local issues in Transport Business Ecosystems (TBE) (such as gendered workplaces, inclusive consultation, entrepreneurship and education).

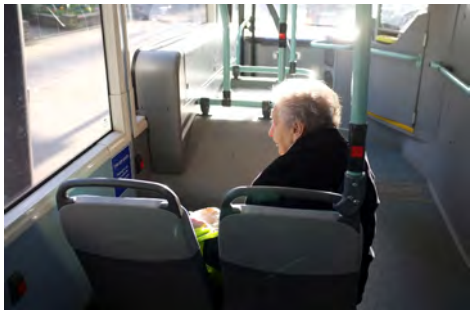
   b. Provide national data relating to the TBE, for example, through standardised surveys on women's mobility.

   c. Act as a beacon for women's engagement in the smart mobility sector.

   d. Provide **'living labs'** drawing on citizen science and participatory design to create gender and diversity-sensitive smart mobility solutions.

3. The development of an **Open Data Repository** – a one-stop-shop for sharing transport-related gender datasets with standardised templates, tools and the General Data Protection Regulation (GDPR)-compliant data management processes.

Our work will be underpinned by key concepts and tools related to intersectionality, gender transport poverty, gendered discourses and scripts and


agent-based modelling.

Proposed impacts will be in areas of:

- **Education and R&I** – gender and role equality in STE(A)M, engineering & design;
- **Employment** – gender bias in opportunities and workplace;
- **Mobility** – increased awareness and use of 'hidden' journeys;
- **Datasets** – standardise, create and merge datasets enabling better data analytics on women's mobility;
- **Entrepreneurship** – document and transfer best practice;
- **Policy** at local, national & international level – more accurate mobility information, integrated planning & diversity in policy-making bodies;
- **Practice** – increase equality in consultation, decision making and employment practices;
- **New knowledge** about intersectionality and gender transport poverty;
- Create **inclusive smart mobility solutions** putting people first;
- **Smart Mobility discourses** – critical analysis and development of new scripts.

What can you do to support us?

TInnGO is initially funded for three years. Over the next two years, we will set up 10 TInnGO labs, as pilots, to support local groups and activities, encourage and train women and other groups in achieving equality in the fields of mobility, education and employment in the TBE. To be more effective and sustainable in the long-term, we need support from readers of this article to:

- Follow, like and link to us;
- Start a conversation with us about your experiences of gender and diversity inequalities;
- Use gender mainstreaming and gender action plans in your organisations;
- Challenge inequality in transport decision making, services and discourses and;
- Contribute and share gender data in our Open Data Repository.

TInnGO has received funding from the European Union's Horizon 2020 Research and Innovation Programme under Grant Agreement No 824349. The consortium brings together 20 partners from 13 European countries, including universities (Coventry University, University of Copenhagen, Technische Universitaet Ilmenau, Politecnico di Torino), research centres (ITENE, VTI), consultancies (Interactions, Signosis, VTM, Smart Continent, Inteco, Lever), local entities (EMEL from Lisbon, Municipality of Alba Iulia, Città di Torino, West Midlands Combined Authority) and companies (sBoing, LGI, plan&rat, Societal).

For further information, visit our website (http://www.tinngo.eu/), the Observatory at http://transport-gender-observatory.eu/ or contact PI, Andree Woodcock at contact@suits-project.eu

TInnGO
Transport
Innovation
Gender
Observatory

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 824349.

Andree Woodcock
Professor
Coventry University
Tel: +44(0)797 498 4460
A.Woodcock@coventry.ac.uk
www.coventry.ac.uk
www.tinngo.eu
www.twitter.com/TinnGoEU
www.linkedin.com/company/tinngo/

Developing and implementing sustainable, inclusive, integrated and accessible transport strategies

Andree Woodcock, a Professor from Coventry University, tells us all we need to know about a four-year research and innovation action project that aims to develop and implement sustainable, inclusive, integrated and accessible transport strategies, amongst many other areas

H2020 CIVITAS SUITS (**S**ustainable **U**rban **I**ntegrated **T**ransport **S**ystems: Transferable tools for Small to Medium local authorities) is a four-year research and innovation action (RIA), entering its final 18 months. Its aim is to increase the capacity of Small-Medium (SM) local authorities (LAs) to develop and implement sustainable, inclusive, integrated and accessible transport strategies, policies, technologies, practices, procedures, tools, measures and intelligent transport systems (ITS) that recognise the end-to-end travel experiences of all users and freight.

It is perceived that SM cities are unlikely to have sufficient resources to develop, support and finance integrated urban mobility plans without a broad range of targeted capacity-building measures. SUITS argues that rather than importing or adapting existing sustainable transport measures or buying in expertise, cities should be supported in building up local capacity (in their governmental institutions, businesses and citizens) to grow, fund and implement bespoke and context-sensitive sustainability strategies, appropriate to their needs.

Playing an active role in the CIVITAS 2020 family, SUITS contributes towards the CIVITAS initiative and adoption of SUMPs across the European Union (EU), as a Member of the Co-ordinating Group of the European Platform on Sustainable Urban Mobility Plans (SUMP), especially concerning innovative financing and procurement and inclusivity. Although integrating with SUMP vsn 2.0, having a SUMP is not a prerequisite for using SUITS' outputs.

In relation to sustainable transport, SUITS argues that capacity-building should embrace change, at the individual, organisational and institutional levels. This includes providing the knowledge and know-how of the latest transport innovations, mobility data usage, rules, regulations and citizen engagement processes. These directly impact how a transport department goes about its business, enabling them to make better, more informed plans. The following sections outline the two main outputs of the project.

Crowdsourcing data

As an RIA project, SUITS has successfully piloted the use of real-time traffic data collection through crowdsourcing in urban traffic management to address issues of both passenger and freight mobility as a low-cost means of gathering, visualising and analysing such data. This method is especially attractive to SM cities. Trials in Kalamaria and Torino indicate not only the suitability of the method but also, the steps which local authorities need to take to guarantee sufficient, reliable and General Data Protection Regulation (GDPR)-compliant data collection. All cities are free to use our Data Repository to access traffic datasets and share their open data with others. SUITS toolset enables the selection and visualisation of large, crowdsourced traffic datasets with the ability to scale efficiently to handle big data. Citizen privacy is ensured by data anonymisation or pseudonymisation techniques, tools and application of strongly secure crypto technologies for data communication and storage. The use of real-time data also features in SUITS CBP, discussed below.

SUITS Capacity Building Programme (CBP)

To understand the needs of the transport departments, SUITS has worked extensively with partner cities (Alba Iulia, Transport for West Midlands, Kalamaria, Turin, Rome and Valencia and follower cities of Dachau, Stuttgart and Palanga) to determine first of all, the existing gaps in knowledge and secondly what changes need to be made within the organisation for

Figure 1. Capacity Building Programme Modules

it to work more effectively, apply, use and measure the impact of capacity-building measures.

SUITS work has confirmed that local authorities (LASs) face many challenges in developing sustainable urban planning measures and deploying innovative mobility solutions and technologies. Despite comprehensive EU Guidelines for developing and implementing such projects, LAs may struggle to perform exhaustive preliminary analyses, develop SMART goals coupled with long-term vision and impact assessment. Furthermore, substantial drawbacks occur in the implementation phase of urban mobility projects, particularly in terms of improving conceptual planning processes and establishing sustainable financing schemes. This derives from the lack of appropriate expertise and organisational structures which impede innovation and barriers to interdepartmental working needed for smart city development.

Requirements analysis of the SUITS cities and reviews of existing guidelines has led to the development and implementation of six tailorable modules, specially designed for SM LAs which aim to:

- Increase the capacity to develop and implement sustainable, inclusive, integrated and accessible transport;
- Support development of SUMPs by transforming them into learning organisations and;
- Increase resilience and responsiveness of transport departments to new challenges and changes.

Six modules (see figure 1) have been developed, acknowledging gaps in existing training material and the needs of SM LAs. These include a Facilitator Guide, appropriate training material delivered either as classroom courses (modules 1-4) or e-learning modules (5-6). The courses have been structured to clarify the value of measures for small-medium cities, analyse a successful case, present innovative financing and procurement procedures tailored to topic requirements, as well as tools and guidelines for the enhancement of measures' implementation and user engagement.

The CBP has been assessed piloted with SUITS cities. Overall evaluation has shown that participants were fully satisfied with the learning ambience and more than 50% gave the highest rate regarding the content accuracy, exercises structure, course structure and achievement of workshop objectives. During the next 12 months, all material will be released (in Italian, Spanish, Portuguese, Greek, Lithuanian, German and Romanian) as the SUITS Capacity Building Manual and Toolbox (freely available to the Open Research Data Portal and the CIVITAS Urban Mobility Tool Inventory). Specifically, the Toolbox will consist of:

- A step by step guide for LAs assisting them in the decision-making process when developing SUMPs;
- An Integrated Decision Support Tool to assist LAs in setting innovative financing, public procurement and project development processes;
- Links to resources such as databases and models that are particularly relevant to transport planning and sustainable mobility planning for Las and;
- Relevant examples and case studies.

The SUITS consortium consists of twenty-two partners from eleven EU countries, among them nine cities in seven EU countries. It is coordinated by the Future Transport and Cities Research Institute, Coventry University, UK.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no 690650.

CIVITAS 2020
Cleaner and better transport in cities
SUITS

THE CIVITAS INITIATIVE IS CO-FINANCED BY THE EUROPEAN UNION

Andree Woodcock
Professor
Coventry University
Tel: +44(0)7974 984 460
A.Woodcock@coventry.ac.uk
www.coventry.ac.uk
www.twitter.com/suits_project

AVENUE: Designing future public transportation services with autonomous vehicles

The AVENUE H2020 project aims to design future public transportation services with autonomous vehicles, a less costly, greener solution for suburban areas, as we discover here

No timetables. No fixed stops. No waiting FOR ages in the rain. The AVENUE H2020 project (1) is designing and operating world-first trials of public transport services with small fleets of autonomous electric buses that collect users on-demand, provide door-to-door transportation and are integrated with existing public transportation services. The use of autonomous vehicles in public transportation provides a less costly, greener solution for suburban areas, where conventional public transportation services are not viable and, therefore, not offered.

The European Union (EU)-funded AVENUE, a four year project which started in May 2018 and coordinated by the University of Geneva, is operating small fleets of autonomous buses in low- to medium-demand areas of four European cities, in Copenhagen, operated by Holo, in Geneva operated by TPG and in Luxembourg operated by Sales-Lentz and in Lyon operated by Keolis.

The project's objectives are, first, to demonstrate that autonomous buses are a promising solution for public transportation in urban and suburban environments, second, to identify the barriers and obstacles in the deployment of autonomous vehicles in shared public transportation, third, to propose and validate new, innovative and disruptive transport services and finally, to provide recommendations and guidelines to all actors, from government to manufactures for future large-scale adoption and deployment of autonomous buses in public transportation.

From the first day of the project in May 2018, all sites were operating an autonomous vehicle service with one or more mini-buses. After a year, all four demonstrators were up and running and new services are now under development to bring them up to the next level. Today, the vehicles involved cover fixed routes, but by the end of 2019, on-demand services will be offered in selected routes.

However, the road to the deployment of autonomous vehicles for public transportation is filled with obstacles and barriers. On one hand, the technology still needs to improve and provide solutions to many issues related to autonomous driving in complex road situations. On the other hand, regulatory restrictions do not allow the full exploitation of autonomous vehicle capabilities on the road and in some cases, block the further research and development of efficient solutions.

On the road and passenger safety first!

The absence of a human driver puts a heavy burden on the autonomous bus in terms of the safety and security of passengers and other road users. Not only must the autonomous driver negotiate different types of traffic on the road, but also protect the bus passengers from sudden breaks and provide assistance when needed.

In the AVENUE project, our partner NAVYA, is developing and testing under real traffic conditions, new driving methods that can adapt the autonomous driver behaviour to road conditions, becoming, for example, more assertive when entering a roundabout, while remaining reserved in the presence of pedestrians. Other partners, CEESAR and AVL, are evaluating risks for passengers and road users to propose improvements and measures for increasing the safety of the vehicles, while Siemens is studying the issues related to the safety and usage of services for passengers and road users with special needs.

Door to door, on-demand, personalised services

AVENUE is preparing to test a world-first on-demand, door-to-door commercial service of autonomous, shared public transportation, extending the existing public transport service. Via a set of mobile services, developed by our partner Mobile-Thinking, users will be able to call a bus at a specific time and place to reach the nearest stop of the backbone system or move around their own neighbourhood, making use of other innovative in- and out-of-vehicles services, ranging from ticketing, to "follow my kid". The intelligent planner and fleet coordinator system, developed by Bestmile, will allow trip optimisation and coordination of the vehicle fleet, guaranteeing a high-quality level of service with minimal delays.

Social and business development

Of major importance for the deployment of autonomous vehicles for public transportation are the questions related to business development and social impact, studied by HSPF and ECP. The cost of operating an autonomous bus is just a fraction of that operated by a human-driven bus (most of the cost relates to the driver). The ease of use, minimal cost and high availability of transport means has the potential to drastically change the passenger behaviour, pushing them to use the service for travelling short distances for which up to now, were not even considering taking a bus. On the other hand, traditional ticketing methods are no longer suitable for on-demand services. Therefore, AVENUE targets to propose new models and recommendations in response to these new challenges.

Barriers and obstacles

Deploying autonomous vehicles on public roads is not a simple task. We have a large number of regulatory barriers to overcome (under strict law, no vehicle can operate without a driver in any European country!), while we need to convince the regulators and citizens when it comes to security for autonomous vehicles. While the State of Geneva is looking at the legal framework that needs to be changed and how to push changes with the political authorities, CERTH, VIF and UniGe are exploring the cybersecurity issues that can compromise the deployment of the autonomous vehicles.

The road ahead

We strongly believe public transportation will be the first business where autonomous vehicles will be mass deployed. The advantages, business opportunities and potential are tremendous. AVENUE aims to open the way; change how we travel in the city and make the use of public transportation a new experience for the passengers.

This project has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No. 769033.

AVENUE

Professor Dimitri Konstantas
Professor
Information Science Institute
Tel: +41 22 379 02 37
dimitri.konstantas@unige.ch
https://h2020-avenue.eu/
www.twitter.com/avenue_project

Electric cars and Ultra Low Emission Vehicles

Electric Avenue, in Brixton, was one of the first streets to be electrified in the 1880s. By 2030, 150 years on, we will need to have achieved a similar feat for all British roads, and the vehicles using them, argues Chris Richards, Head of Policy and Public Affairs at the Institution of Civil Engineers (ICE)

With urgent climate challenge and the potential scarcity of oil in decades to come, it makes sense to decarbonise our roads for environmental and fuel security reasons.

Electric cars and other Ultra Low Emission Vehicles (ULEVs) are often cheaper to run, produce no toxic fumes directly and have a lower impact on the environment over their lifetime, including manufacture.

Whilst government policy is to end the sale of non-zero emission cars by 2040, the decision to legislate for a net-zero carbon target by 2050 has accelerated the need for change.

Infrastructure and funding will need to evolve to allow a fully electric and ULEV fleet as the days of internal combustion engines come to an end.

Addressing the range anxiety barrier

From an engineering perspective, a significant barrier to enabling an electric future is the lack of electrification on our roads.

The vast majority of roads outside of populated areas are geared towards being a relatively simple road surface for traditionally fuelled cars and lorries. Where roads are linked to the grid, it is for relatively low capacity connections for lights, signs and traffic signals.

This means that high capacity, roadside charging points need adapted infrastructure. For anyone buying an electric car for the first time, a key concern will be a fear of running out of power on a long journey and not having anywhere to charge up.

According to Zap-Map, there are 9,236 charging locations across the UK. However, many of these are concentrated in towns and cities where network coverage remains sparse. The effort needed to service millions, rather than the hundreds of thousands of electric vehicles currently on the road, is enormous and would require significant investment.

> "A crucial part of this equation is an investment in storage. Increased battery and other storage capacity, like dams and pumping systems, as well as the development of a smart grid system – which could use plugged-in electric vehicles as temporary storage – will need engineering solutions and government support."

To meet tomorrow's challenge, we will either have to re-engineer our roads to allow charging on the move, as being trialled in Sweden and the Netherlands or install millions of high-capacity rapid charging points in homes, on streets and at service stops on motorways.

A thirst for energy

There is little point in decarbonising our vehicle fleet unless the energy used to power tomorrow's cars and lorries is also clean.

With a growing population, predicted to be 75 million by 2050, ICE predicts that energy generation will need to increase by 34.2GW – or ten and a half Hinkley Point C power plants – by 2050.

The good news is that renewable technologies, like offshore wind, are now competitive, with the strike price for offshore wind falling from £114 to £57.50 per MWh in the last two years.


Chris Richards

Generating additional capacity will need investment not only to expand production but replace ageing oil, gas and nuclear plants.

A crucial part of this equation is an investment in storage. Increased battery and other storage capacity, like dams and pumping systems, as well as the development of a smart grid system – which could use plugged-in electric vehicles as temporary storage – will need engineering solutions and government support.

The carbon fuel crunch

The major policy challenge is how to pay for renovated roads or a greater expansion in electric charging points and the energy networks needed to power them.

Fuel duty is a large source of revenue for the government, raising £28.4 billion in 2019-20 – almost as much as the government spends on all infrastructure. As petrol and diesel decline as a fuel source, this revenue stream will reduce in the coming decades.

ICE released a paper in March this year on how sustainable roads funding for the strategic road network in England could be met by a pay as you go model. Such a system should be in place by 2030.

Lighting up a nation

Just like those Victorian engineers who first connected Electric Avenue to the grid, doing away with gas lamps, the future for road transport is one illuminated by electricity.

> "Whilst government policy is to end the sale of non-zero emission cars by 2040, the decision to legislate for a net-zero carbon target by 2050 has accelerated the need for change."

Establishing a nationwide grid for every street and home at the turn of the last century was as big a challenge as ensuring a rapid charging network for our nation's cars, busses and lorries today. As then, the move from combustion to electricity will be a historic and immense challenge, but it must be met, for our health and for future generations. ■

Chris Richards
Head of Policy and Public Affairs
Institution of Civil Engineers (ICE)
policy@ice.org.uk
www.ice.org.uk
www.twitter.com/ice_engineers

Waste collection fleets: The future is electric

Electric solutions for waste collection fleets are no longer pie-in-the-sky, writes Stuart Cudden from RCV manufacturer Geesinknorba

At Geesinknorba we recognise the urgent need to take action to reduce greenhouse gas emissions and improve air quality across the UK and the European Union (EU). According to UK Government figures, the transport sector is the biggest contributor to GHG emissions in the UK. Moreover, despite a drop of more than 40% in overall emissions since 1990, emissions from the transport sector have only fallen by 2% over the same period. Transport is also responsible for a third of all the UK's NOx emissions, which have been linked to adverse health effects including reduced life expectancy. Putting cleaner vehicles on the road is vital to reducing the impact of this sector on the environment and public health.

Geesinknorba have been pioneering the development of electric solutions for the waste management industry since 2003. Based on lead acid batteries, our first hybrid refuse collection vehicle body won Vehicle of the Year at the CIWM (Chartered Institution of Waste Management) Awards for Environmental Excellence in 2009. Since then we have continued to develop the technology, and our first Li-On Power hybrid was launched in 2013. Truly a next-generation hybrid, the Li-On Power RCV runs on lithium-ion batteries that power the body and the lifts. Offering a high payload, reduced fuel consumption, and near-noiseless collection and compaction of waste, the vehicle can run 24/7 as the battery is recharged automatically while driving, only needing a 'plugged-in' charge once a week.

But our goal was and still is to make waste collection totally emissions free. An RCV uses on average one litre of diesel per kilometre travelled. According to the EU's VECTO tool, one litre of diesel produces 3.13kg of CO_2. If an RCV averages 100km a day, it is producing 313kg of CO_2 every single day it is in use. Assuming an RCV operates approximately 260 days a year, the potential emissions savings of converting just one vehicle to full-electric operation are equivalent to 81.4 tonnes of CO_2 annually.

The opportunity to make a real difference to both air quality and GHG emission is why, in 2017, we launched the first-ever full-electric RCV, the Li-On Power Pro. This ground-breaking technology for the first time offers public and private waste fleet operators the option of a zero-emissions waste collection vehicle. With the introduction of the Ultra-Low Emission Zone (ULEZ) in London and many other towns and cities in the UK expected to follow suit, the need for vehicles that meet the stringent requirements of these zones is only going to increase.

Of course, the source of the electricity must also be taken into account when considering total well-to-wheel emissions. With an increasing number of local authorities in the UK investigating renewable energy generation at their depots, and with 50% of the UK's electricity now from low-carbon sources, the possibility of powering these vehicles entirely using 'clean' energy is becoming more realistic.

That's not the only benefit of our Li-On Power Pro technology. Unlike electric cars, where many buyers are put off by range anxiety and lack of charging infrastructure, waste and recycling collection, particularly urban collection, is the ideal scenario for electric vehicles. Our Li-On Power Pro RCV is extremely energy efficient, easy to handle with no compromise in performance, and can easily achieve the required shifts. Thanks to its low-noise operation, it can also operate in the early mornings and at night, contributing to an all-round better living and working environment.

A major advantage is that the Li-On Power Pro is a chassis-independent system that only requires a high-voltage connection and CAN bus connection from and to the chassis. The single power source for both chassis and body means there is no need to carry additional battery packs. Combined with the compact and lightweight

batteries and the weight reductions achieved through the removal of the diesel engine and fuel tanks, this results in a high payload capacity.

The intelligent LPP module connects with any electric chassis, available from manufacturers such as Emoss, DAF, Man, Mercedes-Benz, and Iveco, and it controls the body dynamically for highly economic energy consumption. In combination with the energy-saving design of the GPMIV waste collection body, our electric RCV uses approximately 1.4kWh per tonne of collected, compacted, and dumped waste – a figure that has been verified by trials across the UK in locations including London, Leeds, Stockton-on-Tees, and Sheffield. In fact, there are currently 12 vehicles out in the field with customers, and general feedback is that both the chassis and body are exceeding expectations.

This means it is significantly cheaper to operate than a diesel, helping to offset the higher cost of acquisition. Results from trials indicate an average daily running cost of between £14 and £18.50 (~€15.50 to ~€20.50), depending on location, with average daily distances travelled between 88km and 175km. At current UK diesel prices, that's a daily cost saving of between £113 and £216 (~€125 and ~€240) per vehicle and up to £56,000 (~€62,000) per vehicle, per year.

Then there are maintenance costs to consider. An electric vehicle has fewer moving parts; there's a lot less that can go wrong. Particularly with a direct drive, maintenance is significantly reduced.

In short, the sums add up. The total cost of ownership of a full-electric RCV is lower than a diesel, the performance is the same or better, and the environmental benefits speak for themselves. These vehicles are not only a good investment financially; they are an investment in the future.

Geesinknorba Group

Stuart Cudden
Corporate Account Manager
Geesinknorba
Tel: +44 (0) 1443 222 301
stuart.cudden@geesinknorba.com
www.geesinknorba.com
www.twitter.com/geesinknorbauk

Emissions-based parking: Delivering cleaner, healthier cities

Peter O'Driscoll, Managing Director of RingGo argues that emissions-based parking delivers cleaner and healthier cities

There are currently lots of discussion about the environmental impact that society is making and how this will affect future generations. Local councils are trying to play their part by ramping up recycling efforts, protecting and improving open space and wildlife, and promoting sustainable building and travel.

Working towards large environmental policy shifts can seem an insurmountable challenge, but working at the local level can make a big difference. Every little helps.

So, as a council, where else can you make an impact? Parking.

Ultra-low emissions zones – great in theory, but hard to implement

In 2019, London was the first city to implement an ultra-low emissions zone (ULEZ) across the city. At the time it was hailed as a "world-leading" vehicle pollution restriction and since enforcement, it has been deemed a success. Drivers who are in cars and vans that do not meet the ULEZ emissions standards are being charged a daily rate. However, the headlines covering how successful London's ULEZ has been, encouraging other cities to follow suit, often leave out some key points.

As many cities have recently experienced, introducing a ULEZ can be a costly and time-consuming undertaking, to the extent that many cities have had to push back launch dates because of delays with the emissions tracking technology and the supporting infrastructure. Not only this, the technology can be difficult to implement and at the speed technology moves, it is likely to be obsolete within the next 10 to 20 years, rendering the millions that local councils have spent on it a waste. Additionally, ULEZs have not been shown to fundamentally discourage drivers from using higher polluting vehicles as drivers may be inclined to drive more within these zones to justify the charge they have to pay.

Emissions-based parking – an effective alternative

On top of implementing a ULEZ, some London Councils have also invested in some easier to implement, cheaper alternatives that also help to encourage environmentally-friendly driving. An example of this is emissions-based parking (EBP), which was first implemented by Westminster City Council in June 2017.

> "EBP parking schemes are already making an impact. Within a year of trailing the solution, Westminster City Council saw a 16% reduction in the most polluting vehicles driving and parking in the city, without any obvious displacement to nearby parking zones."

In a similar vein to ULEZ, EBP uses technology to track and target higher polluting vehicles but specifically when they park, instead of as they are driving around. Low emissions vehicles – such as electric or hybrid vehicles – can pay less to park whilst the most polluting diesel vehicles pay more. Although both ULEZs and EBP ultimately impose a higher charge on drivers with less environmentally-friendly vehicles, each solution tackles driver habits from a different standpoint. While the ULEZ works to discourage driving within a city, EBP instead incentivises motorists to make more environmentally-friendly choices around the vehicle they drive.

EBP falls in line with the European Commission's Euro 6 standard which directs that environmentally-friendly cars should pay less; newer, cleaner petrol and diesel vehicles should pay a standard rate; and the most polluting vehicles paying the highest price.

As most local councils have already migrated the majority of their parking payment systems to cashless app-based systems, EBP can be an easy and cost-effective implementation process. The application that enables parkers to pay for parking can be provisioned to also automatically assess the car, based on real-time data, the vehicle CO_2 fuel emissions and the year of manufacture. Tariffs can then be automatically applied, based on the level of emissions within pre-defined brackets set by the council.

> "In 2019, London was the first city to implement an ultra-low emissions zone (ULEZ) across the city. At the time it was hailed as a "world-leading" vehicle pollution restriction and since enforcement, it has been deemed a success. Drivers who are in cars and vans that do not meet the ULEZ emissions standards are being charged a daily rate"

This technology can also be used to target specific sites or areas under the purview of a local government without any additional infrastructure implementation. EBP technology is also agile, so it can constantly be adapted and improved to meet the needs of the local area. Additionally, as it is implemented as part of a phone parking solution the technology will constantly evolve to take advantage of the latest developments without costing local councils large sums of money.

EBP parking schemes are already making an impact. Within a year of trailing the solution, Westminster City Council saw a 16% reduction in the most polluting vehicles driving and parking in the city, without any obvious displacement to nearby parking zones.

Helping councils and saving the environment

Parking may not always be the first thought people have when it comes to how local councils can implement environmentally conscious policies and may not be a key consideration when listing technology-infused industries. But think again.

Peter O'Driscoll

The parking industry is working toward helping local councils to provide cleaner, healthier and more liveable cities through technology solutions such as EBP.

Emissions-based parking can specifically help local governments and councils manage the pressure from large governing bodies to improve air quality, demonstrate environmental benefits and ultimately make towns and cities better places to live. ■

Peter O'Driscoll
Managing Director
RingGo
Tel: +44 (0)20 3046 0200
www.ringgo.co.uk
www.twitter.com/ringgo_parking

Asset management & maturity in the rail industry

Marcel van Velthoven, CEO of AMOSA, argues that the rail industry has many challenges and in response to this, he explains how asset management and an increase in the maturity of the organisation can assist

The rail industry has many challenges: an increasing demand in capacity, new digital technology, new customer requirements and an ageing workforce. This while the rail industry is one of the industries who have the highest adoption rate of the ISO 55 standard.

How to cope with this?

The rail industry is one of the industries with the highest investments in the market. In Western Europe alone in the next 10 years, the rail industry will invest over €600 billion in maintenance, renewal and expansion of their assets. These must be managed, in particular, to comply with the increasing demand of the regulators, who not only demand good service but also transparency of investment decisions and cost.

To cope with this, many rail organisations have adopted asset management as a practice to streamline their activities and get a good insight into the demands and the performance of their assets. Maintaining this is a challenge, especially given the ageing population of the workforce. Several rail organisations have indicated that between 20-25% of their staff will retire in the next five to 10 years. This is an incredible loss of knowledge and experience, which compensates for the often still limited documentation of the assets in the organisation.

The Amosa team, formerly ZNAPZ, has been working in the rail industry since the mid-1990s, starting with infrastructure in the Netherlands and growing into many other regions in Europe. We first supported companies like Volker Rail and Bam Rail who took over maintenance activities from Prorail, with the right information system. This has been expanded over the last 20 years to become a robust asset management information system, with best practices.

Today, we are working with our rail customers to apply the latest digitisation technology, to make better use of information technology to support their business processes.

What are the key challenges?

With an ageing workforce, it is paramount that the knowledge and experience of the staff, many of whom have 30-40 years been working in the company, been kept. The Equipment Maintenance Assistant from IBM, based on Watson technology, is a tool that enables all kinds of information to be kept and managed. It goes even further, when the data, structured and unstructured is stored, the system categorises the knowledge and starts creating useful information. When patterns, like required maintenance, are planned, the system will advise the staff what to do based on the analysis of the previous years of work. The responsible people can validate the recommendations, add or alter the information, which is then stored as the new best practice.

"...many rail organisations have adopted asset management as a practice to streamline their activities and get a good insight into the demands and the performance of their assets. Maintaining this is a challenge, especially given the ageing population of the workforce."

With machine learning (ML), the system gets wiser by the day and follows the organisation with the new processes, measurements and maintenance practices. It enables all digital data being kept today to run a real-time RCM analysis based on these latest findings.

IBM's Equipment Maintenance Assistant is proof that digitisation can work and support the organisation in their day-to-day operations and take away some headache from the ageing workforce.

How is this supporting the maturity of the organisation?

With the departure of older staff, the organisation matures negatively. The team gets younger, the experience is reduced and risk increases. However, with the right tooling in place, the

organisation is supported with best practices. Now, this knowledge is no longer dependent on one individual, but is available to all staff, at all times and places. Making this information available on mobile devices creates a knowledge base at hand for all people in the office and the field, doing their maintenance work.

How can we make this work?

Like most modern projects today, it is wise to start small. Taking a subset of tasks in a small area with a small team. Registering the day-to-day activities and processes and storing the data that is available and the data that is required. Developing an electronic work package, which will inform the staff when this task is required what and how they should do this. It will also recommend what data must be gathered at the location and for the task to be executed.

When electronic data is available, this will immediately be taken into account by the Equipment Maintenance Assistant, not only during the job but at any moment in time. Developing a 24/7 operations room for the rail organisations maintenance department. With the right dashboard, all the risks become visible and the required investment in time and cost.

Rail infra and rail operators are using the Internet of Things (IoT) today to gather data, however, the data gathered is hardly as valuable as it can be. It requires an increase in the maturity of the organisation to cope with the new processes, educate your staff based on these practices and develop a self-learning organisation from a people and systems point of view.

This will support your ageing organisation and the challenges rail companies have to cope with.

We have started this process together with SBB and created a road map on how this change can be adopted and successfully applied. This will support SBB in their aim to cope with the cost cuts that they are facing, their ageing workforce and the demands on them from a technology and an increased customer expectations perspective.

Marcel van Velthoven
CEO
AMOSA
info@amosa-group.com

ECR: Leaders in mobile ticketing and revenue inspection solutions

ECR design and develop smart solutions supporting transport operators across the globe. With unique hardware in the form of compact, all in one solutions, we help customers to ensure that every ticketing experience is seamless, reliable and easy

ECR design and develop smart transport solutions for the mobile environment. Does your onboard ticketing restrict you and your passengers? Would you like to cut out ticket fraud and chargebacks? Then we can help.

ECR Retail Systems is one of the longest-established mobile point-of-sale (mPOS) specialists in the world and offers a wealth of industry experience in delivering smart solutions to its clients across the globe.

Transport providers including National Express, Stagecoach, LNER, OBB, Big Bus are using our fully mobile technology the world over. From ticketing to onboard retail and hospitality, we produce every aspect of our systems in-house from conception through to final delivery. We even design and manufacture our own hardware, so that clients can rest assured that every solution we supply to them is the best on the market today.

Having become specialists in the transport sector, we set out to deliver a system that encompasses not only state-of-the-art software but also the very latest in hardware technology.

We offer compact and lightweight handheld terminals – developed by our experts for the mobile environment. Features include:

All-in-one design with an inbuilt printer, 2D QR scanner, contactless/ mobile wallet card reader, RFID, ITSO accreditation, 3G/4G mobile network, Wi-Fi, HotSwap battery, carry case. The benefits are proven:

- Real-time ticket validation;
- Anti-fraud prevents pass-back and duplication;
- Customer app and bookings;
- All payment types;
- Real-time reporting and head office dashboards;
- Offline capability, with no loss of functionality.

Whilst selling, the focus is on processing transactions quickly and smoothly – also vital for the overall customer experience. TicketPoS connects with mobile network and Wi-Fi wherever possible and reverts automatically to offline mode when no signal is available. Users are able to continue seamlessly with operations, from ticket and revenue checks to selling onboard.

Kate Hutchinson, Head of Sales

Passengers can purchase and validate tickets & travel cards from print-at-home to physical tickets and e-tickets on any device.

In addition, our system has numerous clever features designed to close gaps, improve cash handling whilst facilitating the move to cashless payments wherever possible. It uses

GPS tracking to deliver real-time and pinpointed sales data delivered on a clear to read head office dashboard.

TicketPoS is cloud-based ensuring that it requires no specific browser or additional software and is accessible from any location by head office users with their individual login.

We support promotions, discounts, agents and commissions, along with multiple other benefits. Not least is the anti-fraud measure in our dynamic QR codes and features in the customer app, which has been designed to give the user complete control over their ticketing purchase, usage and travel.

The Go2 all-in-one contactless-enabled handheld device comes with ITSO accreditation and full PCI compliance, approved EMV levels 1 and 2, for a fully secure solution that is ready to deploy.

The super compact GoFree device operates without a printer and can communicate with portable ticket printers where required. Ideal for validation and inspection, both devices operate with full Windows 10 Enterprise and offer users multiple functionality from equipment and safety checks with a full audit trail, to messaging to and from head office & other users.

TicketPoS fully supports self-scan, reducing pressures on onboard staff where required and is small enough to be carried with ease throughout the working day.

Looking further ahead, at ECR we are working continuously with our clients to identify market trends and new ideas to incorporate into our software and we are always pleased to be able to deliver and help our clients enjoy the benefits of what our systems can do. This year, we continue focusing on giving independence and control to the customer, making the buying process even faster and easier than before. This is set to help ticket sales rise significantly across multiple transport types and we are excited about the opportunities this will offer us and our clients throughout the transport market and beyond.

ECR retail systems

Kate Hutchinson
Head of Sales
ECR Retail Systems
Tel: +44 (0)7787 52 4109
kate@ecr.co.uk
www.ecr.co.uk
www.twitter.com/ECRsolutions

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The financial priorities for France

Here, we take a look at the financial priorities for France, including comment on a modernised European competition policy and the development of sustainable finance

In July 2019, France, Germany and Poland proposed a modernised European competition policy. A meeting in Poland with the Ministers of Economy of Poland, Germany and France highlighted the importance of an industrial policy ambitious for the European Union (EU). At this meeting, the three ministers of these countries presented a joint proposal that concerns modernising European competition policy and adapting it to the increasing digitisation of the economy and global competition. This follows on from France and Germany jointly publishing a Manifesto for a European Policy on European industrial development adapted to the 21st century, back in February 2019.

On this occasion, Bruno Le Maire stated his thoughts on a modernised European competition policy: "We know full well how much France and Europe owe to competition and to European competition rules. But competition is an ever-moving field. In order to retain their relevance and efficiency, rules must adapt to the new economic realities, in particular to the digital revolution and to the increasing concentration observed in the economies of our main partners. Modernising our competition rules is one of the main challenges that the EU will need to address in the coming months.

"A shared European industrial policy cannot work if we do not have a coherent competition policy and a coherent trade policy. The times when these policies could evolve in separate ways is are past us. We must think these three policies globally in order to preserve our industry."[1]

The development of sustainable finance

In other news, the development of sustainable finance was discussed, in that France will make strong proposals at the European level to develop a high-quality non-financial reporting framework. Bruno Le Maire put the development of sustainable finance on the agenda of the meeting of the G7 Finance Ministers in July 2019.

Bruno Le Maire provided detailed comments on the development of sustainable finance: "After the adoption of the Paris Agreement in 2015 and the One Planet Summit in 2017, this meeting marks a new stage in the mobilisation of the financial centre of Paris in favour of green finance. By announcing that the players on the Paris financial centre will acquire by mid-2020 of a coal strategy and an observatory dedicated to green finance, the place is making a far-reaching, fully collective commitment for the first time. The climate commitments will be independently monitored by supervisors. The market players will work on a global timetable for the exit of activity funding emissions from coal.

"This mobilisation must be carried to the international level. At the meeting of the Ministers of the Finance of the G7 of Chantilly, I will invite all my counterparts to work on the reorientation financial flows towards a resilient and low-carbon economy. The President of the Republic will present the progress of finance for climate at the Action Summit United Nations climate change conference next September". [2]

The financial priorities for France

Following on from the above comment, we know that a Meeting of Finance Ministers and Bank Governors took place at the G7 of Chantilly. Here, four priorities for France during this G7 Finance meeting were underlines:

1. Building taxation for the 21st century: A call by France for a new international tax system adapted to the new economic model created by the revolution of the data economy and secondly, introducing a tax on companies at the international level to tackle evasion.

2. Towards sustainable capitalism: As discussed earlier in the article, the country wishes to develop green finance that vitally supports the huge investments required to ensure a successful ecological transition.

3. Build stable capitalism and better combat speculation risks, cyber-risk and excessive concentrations: Measures to address cyberattacks on the financial sector and the role of (virtual money units) in the financial system, including Facebook's Libra project, are examined.

4. Building equitable capitalism: This can be, for example, carried out by strengthening transparency on gaps when it comes to improving sustainable financing of investments in developing countries. In particular, there is a desire here to improve the financial inclusion of women in Africa.

A good place to end this article on is precisely on the thoughts of Bruno Le Maire, Minister of the Economy and Finance, who concisely summarises the financial priorities for the country, which includes a call to sustainability.

"France has an ambition for this G7 Finance: rebuilding capitalism. Capitalism as it exists today, the one that rests on resource depletion, increasing inequalities and tax differences between digital companies and other companies, and that revolts our fellow citizens is doomed to ruin. We want to rebuild capitalism so that it is more just, more responsible and more sustainable." [3] ■

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Open Access Government
editorial@openaccessgovernment.org
www.openaccessgovernment.org
www.twitter.com/OpenAccessGov

Financial markets: The impact of institutional investors on informational efficiency

Adrian Buss, Associate Professor of Finance at INSEAD explains the impact of institutional investors on informational efficiency here in detail, an aspect relevant to all participants in today's financial markets

The importance of institutional investors in financial markets has increased considerably over the last decades. For example, while financial institutions, such as mutual funds, pension funds, hedge funds, banks and insurance companies, owned only 7% of all U.S. equity in 1950, today they account for about 80% of equity ownership. Moreover, they are responsible for a majority of the transactions in today's financial markets.

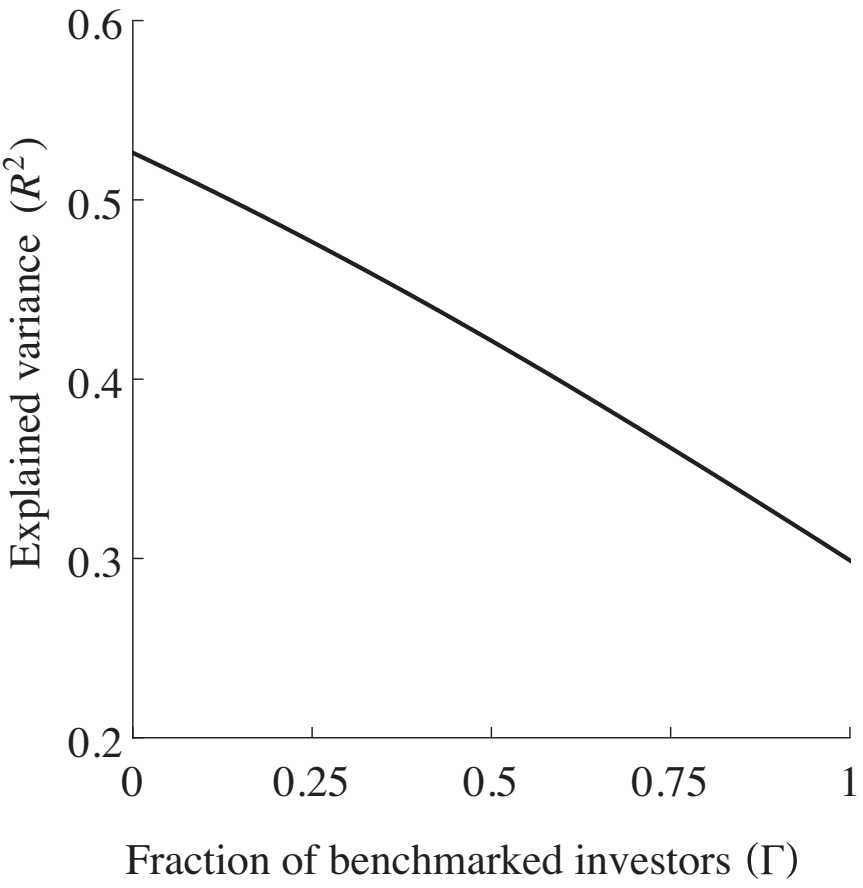
Notably, the objectives of these institutional investors differ from those of traditional households. While both try to manage their funds to maximise portfolio returns, institutional investors are usually also concerned about their performance relative to a benchmark (often a stock-market index). Such benchmarking concerns arise from the observation that financial institutions who beat their benchmark attract considerably more capital from clients in the future. This, in turn, increases future management fees and, hence, future profits. Benchmarking concerns also arise from explicit performance fees. Specifically, to align the incentives of fund managers and their clients, asset-management contracts often specify that managers get paid higher fees if they outperform their benchmark.

This practice of benchmarking can have a substantial impact on financial-market equilibrium because – due to their sheer size – institutional investors often act as the "marginal investor." However, while the impact of benchmarking on asset prices has been studied before (see, e.g., Cuoco and Kaniel (2011) and Basak and Pavlova (2013)), benchmarking might also affect the informational role of financial markets, that is, their ability to aggregate and disseminate information. Intuitively, investors continuously try to obtain "private information" (i.e., information not available to others) by studying financial statements or uncovering information about consumers' tastes or macro-economic trends; with the goal of generating trading profits and, hence, high portfolio returns.

Whenever an investor uses such private information in his or her trading, part of the information gets incorporated into stock prices. For example, if an investor – following positive (negative) firm-specific news – buys (sells) shares of a company, the firm's stock price goes up (down) which, in turn, reveals part of the investor's information to other investors. Thus, by tracking stock-price movements in financial markets, investors can infer private information that other investors possess. The degree to which prices incorporate and reveal information is called informational efficiency and is of foremost importance because it determines the efficient allocation of capital in the economy.

Consequently, the main objective of a recent research project of Matthijs Breugem (Collegio Carlo Alberto) and myself, published in The Review of Financial Studies, is to explore how the growth in assets-under-management by benchmarked financial institutions affects informational efficiency and, in turn, asset prices and investors' portfolio returns. For that purpose, we develop a novel theoretical framework that explicitly accounts for the information choices of institutional investors that are concerned about their performance relative to a benchmark. In the model, investors not only decide on their optimal portfolio but also decide how much capital they want to allocate to the acquisition of private information.

We document two distinct economic mechanisms through which benchmarking affects the information content of financial markets. First, due to benchmarking concerns, institutional investors use a part of their portfolio to replicate the benchmark which, consequently, does not benefit from (more precise) private information.



As a result, private information can only be applied to a smaller fraction of the portfolio which reduces its value. Hence, benchmarked financial institutions invest less in information acquisition. Second, benchmarked institutional investors are less "aggressive" in their use of private information. That is, they trade fewer shares for a given piece of information so that – with each trade – less of the available private information gets incorporated into prices.

Both effects imply a reduction in informational efficiency as the assets-under-management of benchmarked institutional investors increase, as illustrated in the Figure. In particular, while the first effect implies that less private information is available in the economy, the second effect implies that less of the available information gets incorporated into stock prices. Ultimately, all investors can infer less about fundamentals from stock prices; a prediction that is consistent with empirical evidence on the impact of Exchange Traded Funds (ETFs) on stock-price informativeness (Israeli, Lee, and Sridharan, 2017).

This reduction in informational efficiency has important implications for asset prices and the performance of fund managers. For example, because stock prices track fundamentals less closely, stock-price fluctuations are more pronounced, that is, stock-return volatility goes up. Moreover, because institutional investors that are more concerned about their benchmark acquire less information, they earn lower average portfolio returns than their less-benchmarked (i.e., more active) peers.

In summary, our work demonstrates that the growth in assets-under-management by benchmarked financial institutions reduces informational efficiency. As such, it highlights a novel tension between benchmarking as a tool to align the incentives between fund managers and their clients and its adverse effects on individual managers' portfolio returns and informational efficiency.

This work has received financial support from the Europlace Institute of Finance, the Labex Louis Bachelier and the 'Asset Management Academy – An initiative by Paris Dauphine House of Finance, EIF and Lyxor International Asset Management'.

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The Business School for the World®

Adrian Buss
Associate Professor of Finance
INSEAD
Tel: +33 1 60 72 44 84
adrian.buss@insead.edu
https://www.insead.edu/faculty-research/faculty/adrian-buss

The work of the Court of Justice of the European Union

The important work of the Court of Justice of the European Union is introduced here, including details of language arrangements in place and how their work impacts the lives of EU citizens

The Court of Justice of the European Union (CJEU) is responsible for making sure that European Union (EU) law is applied and interpreted applied consistently in each EU country, in that countries and EU institutions abide by the law. Also, CJEU settles legal disputes between national governments and EU institutions and in some cases, organisations, companies and individuals can take action against an EU institution, perhaps if they feel their rights have been infringed.

It's worth noting here that the CJEU is divided into two courts:

Court of Justice is concerned with requests for preliminary rulings from national courts, certain actions for appeals and annulment.

General Court deals with rules on actions for annulment brought by individuals, companies and, in some cases, EU governments. Essentially, this court deals mainly with competition law, trade, agriculture, state aid and trademarks. (1)

The Court of Justice of the European Union

This article will briefly focus on the work of the Court of Justice. 28 Judges and 11 Advocates General work in the Court of Justice, appointed by Member State governments following consultation of a panel who provide an opinion on the suitability of prospective candidates' to perform the required duties. Appointed in office for six years, which is renewable, we know that such eminent people are selected from "individuals whose independence is beyond doubt and who possess the qualifications required for appointment, in their respective countries, to the highest judicial offices, or who are of recognised competence."

On the website of the CJEU, we learn about the important roles of the President, Vice-President, the Advocates General and many more.

"The Judges of the Court of Justice elect from amongst themselves a President and a Vice-President for a renewable term of three years. The President directs the work of the Court and presides at hearings and deliberations of the full Court or the Grand Chamber. The Vice-President assists the President in the exercise of his duties and takes his place when necessary.

"The Advocates General assist the Court. They are responsible for presenting, with complete impartiality and independence, an 'opinion' in the cases assigned to them.

"The Registrar is the institution's secretary-general and manages its departments under the authority of the President of the Court.

"The Court may sit as a full court, in a Grand Chamber of 15 Judges or in Chambers of three or five Judges."

Language in the CJEU

One interesting example of the CJEU's work concerns language arrangements. For example, when it comes to direct actions, one of the 24 official languages of the EU will be used in the application or in other words, the 'language of the case' in which the proceedings are conducted. The website of the CJEU details more information about their language arrangements.

"In appeals, the language of the case is that of the judgment or order of the General Court which is under appeal. With references for preliminary rulings, the language of the case is that of the national court

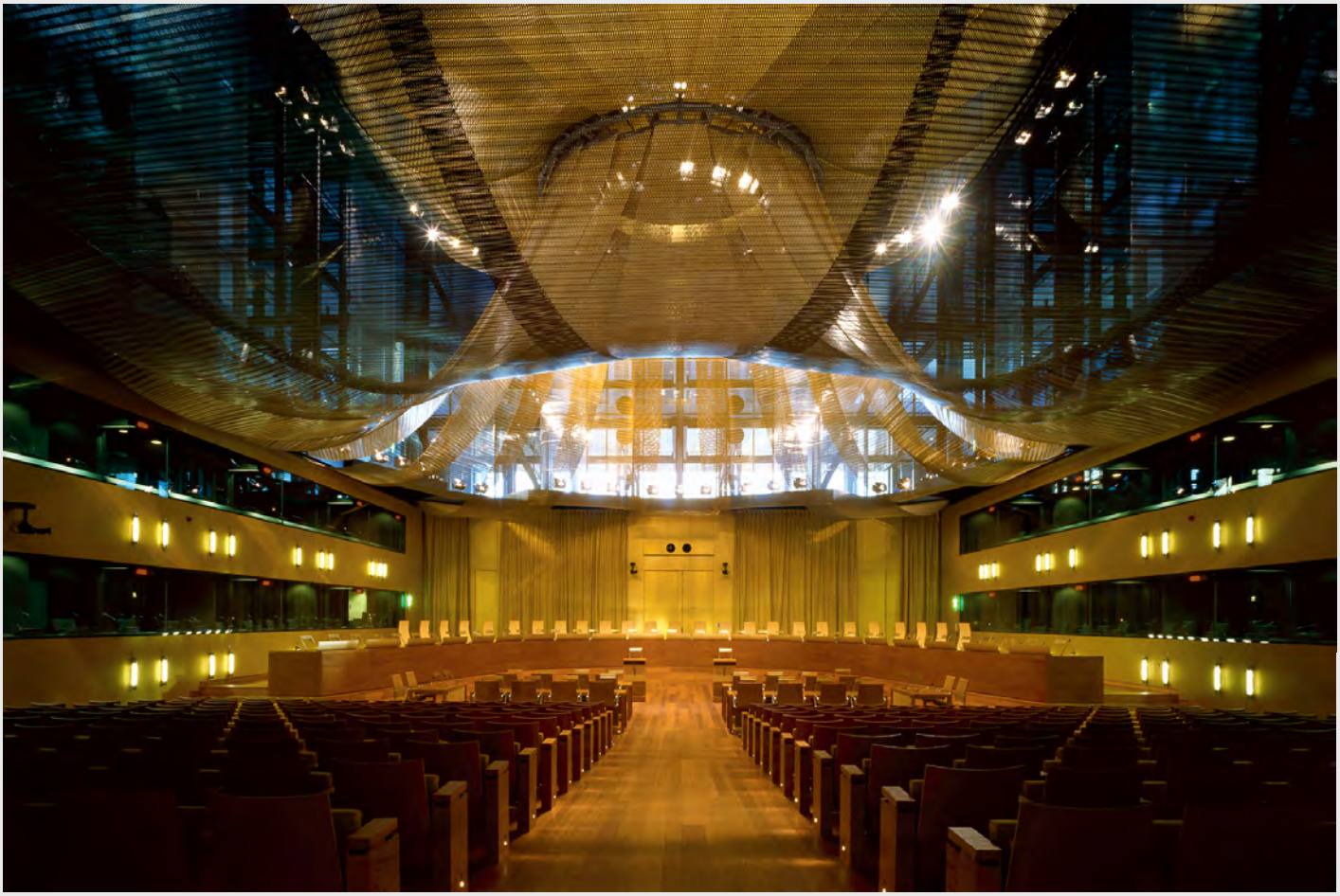

Image: G.Fessy © CJEU

which made the reference to the Court of Justice. Oral proceedings at hearings are interpreted simultaneously, as required, into various official languages of the European Union. The Judges deliberate, without interpreters, in a common language which, traditionally, is French."

Impacting the lives of EU citizens

Finally, it is worth outlining that the CJEU clearly has much impact on the daily life of EU citizens in light of the fact that thousands of judgments are given by the Court, especially preliminary rulings. One example of a judgment given in an important area of EU law is the principle of free movement of goods. Following the Cassis de Dijon judgment in 1979, traders are able to import into their own country any product from another EU country, as long as it is lawfully marketed and manufactured. Another example concerns the respect for fundamental rights; indeed, the Court has contributed greatly to improving the standards of the protection of such rights. One more example concerns European Union citizenship, something that each person is entitled to if they hold the nationality of a Member State, as part of the Treaty on the Functioning of the European Union. [2] ■

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Open Access Government
editorial@openaccessgovernment.org
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The future of the judiciary: Rising above efficiency

Prof Michal Alberstein, PI of the European Research Council funded project 'Judicial Conflict Resolution', discusses her view on the future of the judicial role

The roles of judges in the era of "vanishing trials" – an era in which settlements and plea bargaining far outnumber full and final verdicts – are largely unknown. With the support of a generous grant from the European Research Council (ERC), we are conducting a five-year comparative study in three jurisdictions – Israel, England & Wales, and Italy – to clarify their current and potential roles and to thus help litigants navigate their way through the legal system.

The goals of this wide-ranging research project, the Judicial Conflict Resolution (JCR) Collaboratory, are threefold. First, it seeks to empirically describe the role of judges in promoting settlements, the nature of this involvement, and the various alternative dispute resolution tools employed by judges in this process. Second, the research seeks to advance theory concerning the new roles performed by judges in the courtroom, which will lead to the conceptualisation of a new jurisprudence of Judicial Conflict Resolution. Finally, the research seeks to develop policy recommendations and training schemes for judges, and to establish norms and regulations for the process of reaching settlements.

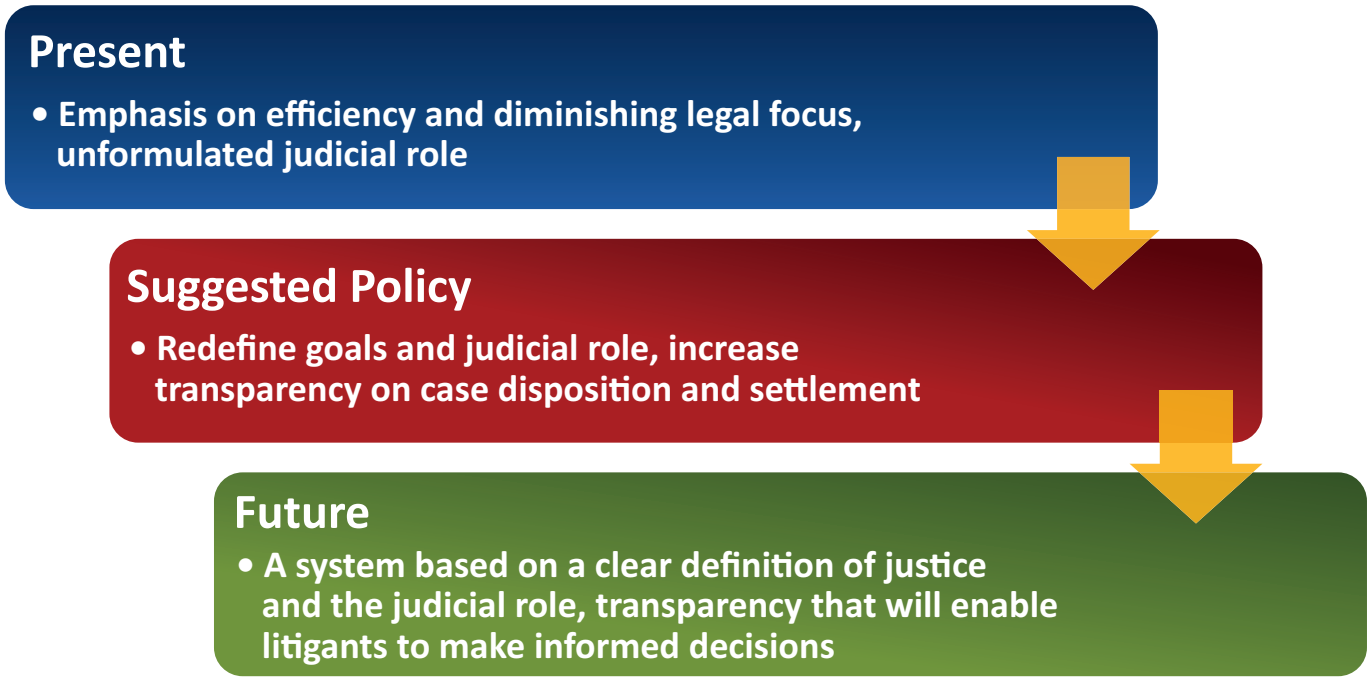
We have found that in the three systems roles of judges have changed as the legal systems strive to minimise the cost and time of legal proceedings. The aspiration for efficiency has led to an emphasis on the pre-trial stage (where sides are encouraged to settle), abbreviated trials, conciliation hearings, and referral to mediation and other alternative dispute resolution processes to reduce the caseload. In the common law systems (Israel, England & Wales), the large majority of cases are disposed of without trial. In Italy, which has a civil law system, we found that this process is beginning, and creating an interesting model of jurisprudence – in which there is a sharp distinction between justice achieved through adjudication and mediation.

While judicial roles have changed dramatically due to the vanishing trial phenomenon, they have not been explicitly formulated in legislation, and are not documented in official public legal records. We found that relevant state-provided data are sorely lacking. We filled these gaps in data through courtroom observations and interviews, as well as a meticulous statistical docket analysis.

In the pre-trial stage – which is often the closest that sides embarking on a legal procedure will ever get to trial in adversarial systems (e.g., case management conferences in England and Wales and pre-trial conferences in Israel), judges use a mix of tools that can be proactive and are mostly characterised by a narrow focus on costs and time. In Israel, these practices also include risk assessment and prediction. In Italy, following reforms to reduce a severe backlog of cases, judges are issuing judicial conciliation proposals and mediation orders during trial.

Prof Michal Alberstein, Principal Investigator

In most cases, in the three systems, judges will not use a broad spectrum of relevant and available conflict resolution methods. This state of affairs raises the question as to the place of efficiency (in terms of time and cost) in legal systems. While efficiency is important and justice deferred is actually justice denied, it does not seem sufficient as an overarching goal of a legal system. In Israel and Italy, no articulation of a concrete perspective of justice exists while constant reforms have focused on effective case management and pre-mediation mandatory meetings. In England such an attempt to clarify the goals of the legal system has been made – with a focus on "access to justice" together with the designation of adjudication as a "last resort" for civil law cases.



However, this formulation was made in the shadow of severe budgetary cuts to the civil justice system, and many litigants, including the disadvantaged, are at times barred from entering the court due to high costs. Mediation, too, falls short of its promise, and is largely influenced by the institutional drive for efficiency and settlement rather than the interests and needs of the parties. Within the two adversarial cultures examined, neither adjudication nor substantial ADR are common – the public loses both ideals.

Interestingly, we found that in Italy, in which the judiciary is inspired by the inquisitorial tradition, the dichotomy between mediation and adjudication is more preserved and judges maintain their roles as legal truth seekers, while acknowledging the other dimensions of conflict that mediation can address.

Following our research findings thus far, our recommendations as to the future of the judiciary are as follows:

Coherent dispute system design of the court system. The desired goals of the legal system, including the role of judges, should be discussed and explicitly framed and implemented through theory building and articulation of values. Theorists and policy-makers may experiment with conflict resolution as the dominant goal, making adjudication an alternative door, and considering whether judges are active leaders in the system or have a different, supplementary role. Following this theory-building, judges should be trained accordingly.

Increased transparency and data collection. Accurate data should be collected and made available so that parties (whether they be consumers or tort claimants) can make informed choices and have a real perspective on what happens when settlements are the norm. This follows our finding that data on rates of settlements and outcomes of legal verdicts are mostly inaccurate and inaccessible to litigants as they try to process their disputes. Full records of court settlement hearings and all forms of abbreviated trials should also be made available. The electronic legal file should become a universal framework to collect data in ways that will enable parties to learn about the reality of legal settlements, and for scholars to compare among legal systems. This will also have an effect on the judicial role by reducing the caseload.

Ultimately the determination of judicial roles should be a result of a thorough deliberation among the various stakeholders in the legal system. A conscious decision and a push for transparency is much better than the currently abstruse reality.

JCR COLLABORATORY
Judicial Conflict Resolution Research Group. Prof. Michal Alberstein

Prof Michal Alberstein
Principal Investigator
Bar-Ilan University
Tel: +972 03 5317 098
Michal.alberstein@biu.ac.il
www.jcrlab.com

The Advocate General at the Court of Justice of the European Union: The linguistic aspect

Dr Karen McAuliffe, PI on the European Research Council funded project 'Law and Language at the European Court of Justice', discusses the impact of language and multilingualism on the role of Advocate General at the Court of Justice of the European Union

This article is the fourth in a five-part series focusing on the ERC-funded project 'Law and Language at the European Court of Justice' (the LLECJ Project) – read the previous articles here.

Law and Language: Understanding multilingual EU Law

Linguistic cultural compromise in EU law

'Linguistic Precedent' in European Union Law

This article focuses on the LLECJ Project's third sub-project: The impact of language and multilingualism on the role of Advocate General (AG) at the Court of Justice of the European Union (CJEU).[1]

The role of the AG is to deliver an independent reasoned opinion in certain cases before the CJEU, as to the response s/he considers should be given to the problems raised in such cases. Although AGs' opinions are not legally binding, they play an important role in the development of European Union (EU) law. The opinion provides a type of 'dissenting judgment' and AGs can act as the CJEU's 'sparring partner' by challenging the Court to tackle issues in a manner that allows EU law to grow and develop.

Since the opinion is not limited to answering legal questions raised by the parties to a case, AGs can be speculative in a way that the CJEU cannot be in its collegiate judgments. AGs' opinions resemble academic texts to a large degree, drawing on various sources of law, earlier CJEU decisions, national jurisprudence and other sources. As such, they go well beyond providing a commentary on the question(s) in a particular case: identifying trends, testing for potential inconsistencies in the case law and highlighting possible future developments. AGs are thus seen as drivers of EU law, and their opinions inject creativity in the development of EU jurisprudence in a way that CJEU judgments simply do not.

Prior to 2004, AGs drafted their opinions in their own mother tongues. This, together with other factors, meant that issues of multilingualism and translation rarely constrained the text of opinions. In 2004, with the mega-enlargement of the EU, which introduced a further 10 official languages to the list of then 11 (with three more added in the interim), a convention was introduced at the CJEU whereby AGs are expected to draft their opinions in one of the Court's pivot languages (at the time of writing: French, English, German, Spanish and Italian).[2]

This convention, which does not affect most of the permanent AGs, means that since 2004 some AGs have been writing their opinions in languages other than their mother tongue (usually English or French). This sub-project sought to examine changes in the linguistic aspect of the AG's role since 2004, and to determine what implications (if any) those changes might have for the construction and consolidation of CJEU jurisprudence. The research questions investigated in this sub-project included:

1. To what extent has language use had an impact on the usefulness of AG opinions?

2. Are AGs' opinions becoming more constrained by language/translation?

3. Do opinions of AGs drafting in their mother tongues differ linguistically from those drafting in the CJEU's pivot languages?

To investigate those research questions, an interdisciplinary mixed-methods approach was taken. A systematic literature review demonstrated that the literature tends to link 'influence' and 'usefulness' of opinions with persuasion, and the general consensus is that language plays a fundamental part in one's ability to persuade.

Empirical observational and interview data demonstrated: (a) that AGs' opinions are a collective endeavour; (b) the change in drafting convention in 2004 heralded a shift in roles not only within certain AGs' cabinets (chambers), but also for lawyer-linguists who have taken on a new role of 'linguistic assistance'; (c) all of those involved in producing AGs' opinions acknowledge the importance of using language to craft 'persuasive' opinions.

Finally, corpus linguistic analysis demonstrated that post-2004 opinions drafted in non-mother tongue languages are stylistically simpler, and include more markers for translation variables, than pre-2004 opinions drafted in mother-tongue languages. Interestingly, however, we see very similar shifts in stylistics in post-2004 opinions drafted in mother-tongue languages. This may be due to many factors, including the composition of an AG's cabinet, but may also highlight an interesting example of the CJEU's institutional language influencing its jurisprudence, regardless of drafting language. Further research is planned to investigate the new questions raised in this regard.

Ultimately this research has demonstrated that language has a measurable impact on the style, and arguably the substance, of AGs' opinions. Such findings must be further investigated to determine their significance in legal scholarship. Only through such interdisciplinary research can a holistic understanding of the development of EU jurisprudence be achieved.

More information about the LLECJ Project, including papers and other project outputs, can be found on the project website. This article series will conclude in the next issue of OA Government, with a summary of the LLECJ Project's findings thus far, and a look toward what such findings may mean in the context of Law and Language scholarship, and EU law.

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1 Particular thanks for assistance with the preparation of this article goes to my UG Research Assistant at the University of Birmingham, Anant Rangan.

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Karen McAuliffe
Reader in Law and Birmingham Fellow
School of Law, University of Birmingham
Tel: +44 (0)121 414 7269
k.mcauliffe@bham.ac.uk
www.karenmcauliffe.com
https://twitter.com/dr_KMcA

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Karlsruhe Institute of Technology

The Calorimeter Center – Advanced Materials and Batteries

Ensure your Lithium-ion cells perform well and are safe

With six Accelerating Rate Calorimeters of different sizes – from coin cell to large pouch or prismatic automotive format – and extremely sensible Tian-Calvet calorimeters the Calorimeter Center at the IAM-AWP of KIT offers the evaluation of thermodynamic, thermal and safety data for Lithium-ion and post-Lithium cells on material, cell and pack level. These data can be used on all levels of the value chain – from the safe materials design up to the optimization of the thermal management and the safety systems. Our fields of research and range of tests encompass both normal conditions and abuse conditions:

Normal condition tests include:

- Isoperibolic cycling, which provide constant environmental temperatures;
- Quasiadiabatic cycling, which ensure that there is almost no heat exchange between the cell and the surroundings

Each of these allows:

- Measurement of temperature curve and distribution for full cycles, or application-specific load profiles;
- Determination of generated heat;
- Separation of heat in reversible and irreversible parts; and
- Ageing studies.

Abuse condition tests include:

- Thermal abuse – heat-wait-seek, ramp heating and thermal propagation test;
- Electrical abuse – external short circuit, overcharge and overdischarge test; as well as
- Mechanical abuse – nail penetration test.

Each of these allows:

- Temperature measurement;
- External or internal pressure measurement;
- Gas collection;
- Post-mortem analysis; and
- Ageing studies – change of risk potential with increasing ageing degree.

INSTITUTE FOR APPLIED MATERIALS – APPLIED MATERIALS PHYSICS (IAM-AWP)

CONTACT:
Dr. Carlos Ziebert
Head of the Calorimeter Center, KIT, IAM-AWP
+49 721 608 22919, carlos.ziebert@kit.edu
http://www.iam.kit.edu/awp/english/177.php
https://www.openaccessgovernment.org/calorimeter-batteries/53640/

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