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## THE FINANCES OF THE EU, INCLUDING THE RESEARCH BUDGET

THE FINANCES OF THE EUROPEAN UNION ARE PLACED UNDER THE SPOTLIGHT BY GÜNTHER H. OETTINGER, COMMISSIONER FOR BUDGET & HUMAN RESOURCES

Commission européenne  
European Commission

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DEVELOPMENT OF CULTURAL AND  
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ANNA LINTON AND JONAS MICHANEK

## GREEN SHIFT

A HANDBOOK FOR ENVIRONMENTALLY  
FRIENDLY REGIONS IN EUROPE

EXAMPLES FROM REGIONS IN ÖRESUND, KATTEGAT AND SKAGERRAK



SVEIN TVEITDAL

## 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.

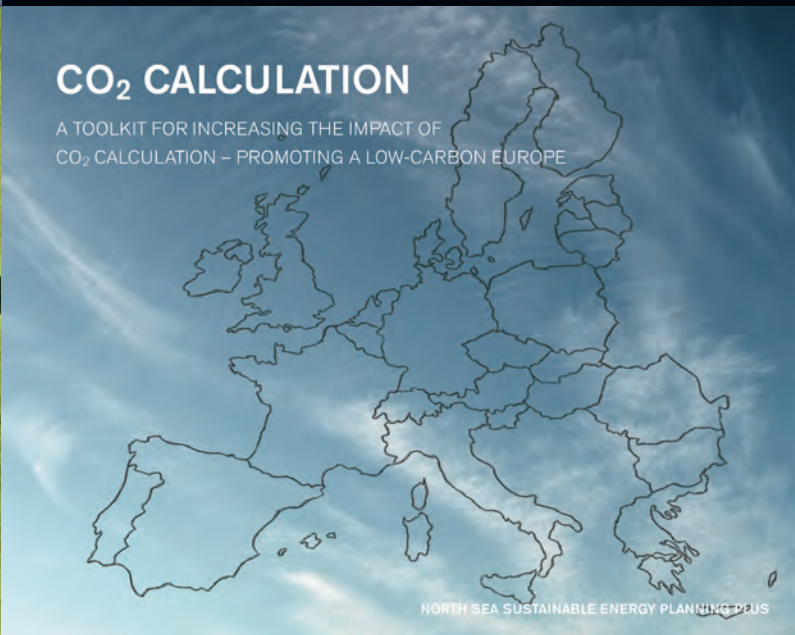
## TO DO

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.

## CO<sub>2</sub> CALCULATION

A TOOLKIT FOR INCREASING THE IMPACT OF  
CO<sub>2</sub> CALCULATION – PROMOTING A LOW-CARBON EUROPE



NORTH SEA SUSTAINABLE ENERGY PLANNING PLUS

## CO<sub>2</sub> CALCULATION

A TOOLKIT FOR INCREASING  
THE IMPACT OF CO<sub>2</sub> 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<sub>2</sub> 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

**Javier Doz Orrit**

**EESC Member for the Spanish Comisiones Obreras Trade Union  
and Rapporteur for the EESC opinion on the 2021-2027 MFF**

European Economic and Social Committee

On 2nd May this year, the European Commission presented its proposal for a European Union (EU) Multiannual Financial Framework (MFF) for 2021-2027. Since then, we are getting to grips with a series of sectoral legislative proposals that together, make up the complex legal architecture of forthcoming EU budgets.

For the seven-year period, the Commission plans overall expenditure of €1,134,583 million (in 2018 prices, throughout this article). This represents a 5% increase over the current 2014-2020 MFF, but since seven-year periods are concerned, in fact, entails a reduction compared to the size of the economy of the EU of 27 Member States (EU27), falling from 1.16% of Gross National Income (GNI) to 1.11%.

This is a further downward step in a process that began in the 1990s, yet another symptom of the political crisis afflicting the EU – a crisis which no-one seems to have either the will or the ability to tackle. Not even the Commission, which on this occasion has given in without a fight. It could see that, as well as the ever-growing group of Eurosceptic governments, the Netherlands government was heading a group of 12 others who want a cut matching the United Kingdom's entire net contribution to the EU (some €10 billion a year). Possibly prompted by the entirely reasonable aim of having the MFF adopted at the summit in Sibiu (Romania) on 9th May 2016, before the European elections (23 to 26 May 2019), the Commission decided that more than half (€70 billion) of the British contribution would be cut, with the other part being covered by new own EU resources.

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**“It is unacceptable that, at a time when the consequences of the social cohesion crisis in many Member States must be faced, the Cohesion Fund should be reduced by 46%, the Regional Development Fund by 12% and the European Social Fund by 6%. Neither is the impossibility of properly funding the new CAP reform, closely tied in with climate protection, acceptable.”**

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This cave-in is, however, inexcusable. With the social consequences of the crisis still raw in many countries, plus the European political crisis even more acute and a debate on EMU and EU reform open, but with no prospect of a clear solution. Also, with a neighbourhood and a world riddled with geopolitical risks both old and new – including the electoral rise of national and extreme right-wing parties and the emergence of authoritarian leaders and governments whose actions run counter to the principles and values of the EU – only strong and ambitious budgets can provide European policymakers with the means to act – and hope – faced with citizens who are confused, angry and ripe for manipulation.



There is a positive side to the Commission's proposal. The structure, flexibility and synergies it introduces are improvements on the current version. It must be acknowledged that nearly all the spending priorities are well-chosen: I+D+i, with €91 billion (+ 31%) for the Horizon programme; migration and borders with €30.8 billion (+ 210%) – with no common policy, however; Erasmus+, with €26.3 billion (+ 93%); and strategic investment, with €44.4 billion (+ 39%). There are two new programmes: the European Defence Fund, with €11.5 billion – although the ethical limits of research and production in this sector of industry have not yet been set – and the Support Reform Programme, with €22.2 billion.

The problem is that the increase in these areas comes at the cost of deep cuts in cohesion policy (- €37 billion, - 10%) and the Common Agricultural Policy (CAP) (- €60 billion, - 15%). It is unacceptable that, at a time when the consequences of the social cohesion crisis in many Member States must be faced, the Cohesion Fund should be reduced by 46%, the Regional Development Fund by 12% and the European Social Fund by 6%. Neither is the impossibility of properly funding the new CAP reform, closely tied in with climate protection, acceptable.

The critical analysis of the post-2020 MFF set out in the [opinion of the European Economic and Social Committee \(EESC\)](#) is accompanied by a number of proposals from the representatives of European civil society. The main proposals: resources should be increased to 1.3% of GNI (as also urged by the European Parliament) and financed by EU own resources, implementing the tax proposals made by the High-Level Group chaired by Mario Monti (VAT, the new Common Consolidated Corporate Tax Base, digital economy multinationals, carbon emissions, etc.); cohesion policy and the CAP must have resources at least the same as those under the current MFF.

The conditions for co-financing investment via existing funds for the countries with the greatest problems should be more flexible; a specific programme must be adopted so that the Member States can finance the European Pillar of Social Rights ([2017 Gothenburg Declaration](#)); more investment is needed to close the major gap opened up by the crisis; and priority must be given to all steps that uphold the Sustainable Development Goals (SDGs) of the UN's Agenda 2030.

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**“For the seven-year period, the Commission plans overall expenditure of €1,134,583 million (in 2018 prices, throughout this article). This represents a 5% increase over the current 2014-2020 MFF, but since seven-year periods are concerned, in fact, entails a reduction compared to the size of the economy of the EU of 27 Member States (EU27), falling from 1.16% of Gross National Income (GNI) to 1.11%.”**

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Showing determination to adopt ambitious budgets that serve the interests of the vast majority is more important than adopting poor budgets in advance of European elections. Exactly the same can be said about EU reform. The challenges and the risks are too great. ■





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# INTRODUCTION

I am delighted to welcome you to the January 2019 edition of Open Access Government and would like to take this opportunity to wish all our readers a very Happy New Year. I hope that you have come back refreshed from the Christmas break and feel ready for the challenges that 2019 brings you.

On a strong note of positivity, our extensive and insightful health and social care focus in this edition is headed up by prestigious contributions from the Minister of Social Affairs and Health in Finland, Pirkko Mattila, as well as Riina Sikkut, Minister of Health and Labour of the Republic of Estonia.

Amongst the many health focus areas, one worth mentioning here is neurodegenerative disorders. One of the many helpful articles comes from Dr Carol Routledge, Director of Research at Alzheimer's Research UK, who charts the priorities for medical research when it comes to dementia and Alzheimer's disease. Another comes from Chief Executive of the Huntington's Disease Association, Cath Stanley, who shares the latest updates on Huntington's research from the 2018 European Huntington's Disease Network conference.

In our research & innovation section, a number of contributors offer their thoughts on the European Commission's Horizon 2020 programme and there is some very interesting reading to be enjoyed around this. We welcome a superb article from Günther H. Oettinger, Commissioner for Budget & Human Resources at the European Commission, who places the finances of the European Union, including the research budget,

under the spotlight. We also welcome comment from Jan Palmowski, Secretary-General of the Guild of European Research-Intensive Universities, who details the issues at stake for the continuation of this area of policy.

While there are so many highlights in this edition, I do want to mention the article we have from Cllr Imran Khan, Bradford Council and Portfolio Holder for Skills and also Key Cities, who examines the UK's productivity puzzle, and asks what can we learn from the UK's mid-sized cities. I was fortunate to attend a hugely enjoyable Key Cities event this year at the tranquil location of Church House Westminster, next to Westminster Abbey in the heart of London.

Finally, I am very pleased to include a piece by Danish Minister for Transport, Building and Housing, Ole Birk Olesen. In his article, he explains the introduction of a new rail signalling system for the country, including the challenges when it comes to the successful deployment of the European Railway Traffic Management System (ERTMS).

So, as we journey into 2019, I warmly welcome your suggestions for opinion-based articles for future editions of Open Access Government, with further editions scheduled for April, July and October this year. ■

**Jonathan Miles**  
Editor



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# The future priorities of the healthcare sector in Finland

Minister of Social Affairs and Health in Finland, Pirkko Mattila, reflects on the future priorities of the healthcare sector in Finland

Society is in a constant state of change. To keep up with the pace of development, we must prepare for the future by envisioning how our society may change and by planning accordingly.

Finland attaches great importance to tackling non-communicable diseases (NCDs). Currently, NCDs are the major cause of premature deaths, suffering, disability and lost opportunities. Therefore, WHO Independent High-level Commission on NCDs published “Time to deliver” in June 2018, a report which comes with six key recommendations. Compiling concise, bold and actionable recommendations was not easy but Finland is satisfied with the outcome. We focused on a strategic approach, which fits into different contexts from global to local level. I am particularly happy that the report emphasises the importance of tackling socioeconomic inequalities and transforming health systems towards more integration, health promotion and public health work.

Now it is time to move from commitments to action. The second phase of Commission work aims to engage in political advocacy for NCDs including promoting the implementation of the recommendations.

In Finland, we have traditionally worked across sectors to tackle health inequalities. The on-going health and social services and regional government reform will define elements of cross-sectoral work structures on the regional level. This will open up completely new opportunities for health promotion, as the counties will be responsible for health and social services, employment and economic development services, and the planning and steering of the use of regions.

The current government has disseminated and implemented best practices, targeting them on population

groups whose well-being and health are poorer than average. In the future, we need to adopt social marketing and service design approaches to reach vulnerable groups effectively. Simultaneously, we need to develop everyday environments, so that they provide all with equal opportunities and vulnerable groups with additional support.

One important way to enhance citizens’ health in Finland is the National Immunization Program (NIP). It protects Finnish boys and girls against twelve different diseases. The NIP has developed through decades of extensive research on disease epidemiology, vaccine immunology, safety and effectiveness, as well as economic evaluation of different vaccination strategies in the Finnish healthcare system. As a major public health achievement, the Finnish NIP has dramatically reduced the burden and costs of vaccine-preventable diseases.

The NIPs evolve with new vaccines and new evidence-based vaccination strategies becoming available. We are currently considering extending HPV-vaccination from teenage girls to boys also, the introduction of shingles vaccination and pneumococcal vaccination in elderly or medical risk groups as well as different strategies for protecting the population against pertussis. Finland is also one of the few countries in the EU that provides all healthy children with the annual seasonal influenza vaccine.

As the NIP continues to develop, the focus is also on the delivery side. Extensive efforts are being made across the healthcare system to ensure that the vaccination coverage remains high in all areas and population groups.

An essential factor in NCD work is the continuous training of healthcare professionals. In Finland, medical and





*Pirkko Mattila, Minister of Social Affairs and Health, Finland*

dental education are publicly funded by the state and the counties. Both healthcare providers and universities, who give such education, are eligible for compensation. The novel thing in the reform is that every healthcare provider – whether public or private – who takes part in the publicly funded healthcare, has to educate healthcare students and they receive monetary compensation for it. The county, which hosts a university hospital, would receive the funding and deliver it in its area. However, as a prerequisite for funding, the counties need to have a training agreement with the universities responsible for medical and dental education. Another determinative factor is that the university considers that the education given meets its quality standards.

When thinking of the future, technology development cannot be bypassed. Finland defines its future research and innovation activity priorities in the National Health Growth Sector Strategy and Road Map. The objective of the strategy is that Finland is the source and user of versatile and high-quality scientific research, inventions and innovations. The roadmap includes activities like implementing the Act on the secondary use of social and health data, establishing new for example genome and cancer centres of excellence and enhancing the joint activities of the biobanks.

Finland needs to make full use of the opportunities of the digitalisation, ICT, artificial intelligence (AI) and robotics in order to guarantee the well-being of citizens and funding for the service system. New technologies help professionals provide better service and care, help people live healthy lives independently and safely in their own home and help recover functional and working capacity quickly through rehabilitation. This is our way of building a healthy society and sustainable well-being. ■

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# Integration: A cornerstone of Eksote's customer-oriented service development

Merja Tepponen South Karelia Social and Health Care District (Eksote) explains why integration is a cornerstone of the organisation's customer-oriented service development

**S**outh Karelia Social and Health Care District (Eksote) is a municipality-owned public sector social and health care provider, with a yearly budget of approximately €450 million. Also, over 4,000 employees provide health services, family and social welfare services, and services for senior citizens that promote health and everyday wellbeing and functioning. Eksote comprises nine municipalities and the population in the area is approximately 130,000.

The integration that led to the founding of Eksote in 2010 focused on removing administrative and organisational borders between nine municipalities' service provision (social and health care services), social and health care services and primary and secondary health care.

Eksote ensures that the expense development remains steady and the regional service needs are fulfilled in suitable ways. The upcoming population structure changes are anticipated, and services, as well as the service structure, are already modified accordingly: this means that the independence of citizens and the possibilities to use e-services and low threshold services enabling such independence are of great importance.

The critical examination of social and health care premises in conjunction with operational models influences investment decisions in South Karelia

(Finland) concerning possible renovation and extension needs. Outsourcing and privatisation should be done not until after the premises resolutions and operations are regionally defined – the focus should, instead, be on partnership development.

The ageing population is not the only factor that is increasing the pressure to the expense development – new statutory obligations in social and health care (for example, the transportation services for the disabled, dental health care emergency duty), as well as other factors (such as the increase in child protection), have an influence on the expense development.

## **Administrative and functional integration towards value-based management**

One of the main reasons for establishing Eksote was the need to ensure the availability of adequate social and health services to all citizens within the region with the limited financial resources of the participating municipalities. Instead of providing local services themselves, municipalities entered into service contracts with Eksote, based on the needs of their residents.

The Finnish health care system has up to now, been largely structured around municipality-based units. Integrating the social welfare and health care services of municipalities within a region responds to the challenges and

opportunities that lie in questions concerning economy, efficiency and service quality in a customer-oriented way, (such as, equal access, continuity, client-orientation, and need-based services). The integration improves the balance and coordination between primary care, social services and hospitals, coordination in strategy, financing and investments by the owner municipalities, common use and the recruitment of staff, and possibilities to meet the future challenges. The integrated framework enables developing truly integrated care processes and service network within the whole region. Due to this integration, for example, the same electronic patient record system is used in the health care centres and hospitals of all municipalities belonging to Eksote.

## **Towards service integration ecosystem and value-based management**

Eksote has developed from municipal-based service structure into an administratively and increasingly functionally integrated service structure and is preparing for the future and being part of a service ecosystem. Through integration, Eksote has achieved a functional and an operational form which allows social and health care services to be optimised in the South Karelia region, leading to better-coordinated care processes to citizens. The aim is to participate actively in building a future social and



health care ecosystem where national entities are tightly integrated to the proactive support of a citizen's wellbeing.

Eksote is beginning gradually to shift from hierarchy-based steering, into knowledge/value-based management that yields even more value. Together with different actors from public, private and third sectors, the organisation is, for example, actively searching innovative answers for service guidance, personal budgeting, unemployment, care and rehabilitation etc. Eksote has also created innovative public contracts.

### **Eksote's vision emphasises a citizen's functional ability and wellbeing in daily life**

Eksote's vision, "Making it easier to cope at home" accentuates the active role of customers and patients in maintaining their health and wellbeing and leading their own kind of life. It signals the need to renew operating models, service chains and structure in social and health care that enable to be the case in a much better way than was previously possible.

The vision is based on a view that home is the best place for everyone and it should be made possible to return there as quickly as medically possible and with ease, (instead of staying in institutional care or hospital if is not medically necessary). Eksote provides a continuously growing number of services that are available at home, to support living there and to provide home rehabilitation, if required.

### **Towards "out-of-hospital"-services**

In the Eksote region, many new services have been tested and partnerships with many voluntary bodies have been very useful and encouraging. Especially in the area of digitalisation, which gives many new tools to improve the results of prevention and wellbeing. Robotics and artificial intelligence (AI) provides a totally new vision for the development of efficient services for citizens.

In Eksote, the integration of structures and clinical practice is completely implemented. As a result, it has been possible to create and develop new

kind of "out-of-hospital" services, which brings new value to all parties of care. On the Internet, you can watch an interesting video presenting [Eksote's "out-of-hospital" services and financial results of these new services.](#)

A health care strategy, like any good strategy, involves a sequence of steps over time, rather than an attempt to change everything at once. This undertaking is complex, but the only real solution is to align everyone in the system around a common goal by doing what is right for the patient.



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Image: © Johannes Arro

*Riina Sikkut, Minister of Health and Labour of the Republic of Estonia*

# Personalised medicine in Estonia: Breaking down healthcare silos

Riina Sikkut, Minister of Health and Labour of the Republic of Estonia offer her thoughts on personalised medicine and how this is breaking down healthcare silos

Predicting disease before it occurs, and individually targeted treatment are the two tenets of personalised medicine, the next wave of healthcare innovation poised to revolutionise treatment efficacy and patient experience ([Mathur & Sutton, 2017](#)). Estonia is taking this innovation one step further by implementing personalised medicine into the primary care system, with a strong focus on prevention, while most other countries are using it in the treatment of cancer and rare diseases.

Estonian personalised medicine is as much about scientific progress and discovery, as it is about technological innovation and patient-centred healthcare. Estonia is currently delivering the national personalised medicine strategy of 2016-2020, which aims to deliver personalised health recommendations to 500,000

Estonian gene donors, target 160,000 women at high risk for breast cancer with personalised screening and reach 200,000 people with high risk of ischemic heart disease to prevent the more serious disease impact. This initiative will be accomplished with the help of the Estonian Genome Centre, a global leader in genomic science with two decades of experience.

Known as the most digitally-advanced society in the world ([Forbes, 2018](#)), Estonia is true to form in the technological and entrepreneurial goals of the personalised medicine strategy and plans to develop a comprehensive IT infrastructure connecting the digital health records, patient portal, health insurance data and the clinical software interfacing health professionals. The first use case of this platform will be in the area of pharmacogenomics, where Estonian gene donors will



receive personalised feedback on the suitability of potential medication, supporting health professionals in their prescription decision-making.

Such a comprehensive development of the digital health system in Estonia and the addition of genomic science into clinical practice requires buy-in from key stakeholders such as health care professionals, health policymakers and the scientific community, as well as strong interdisciplinary collaboration. The Estonian Government has initiated a partnership between organisations representing all key stakeholders to ensure the potential of personalised medicine is successfully executed and implemented in the healthcare system and provides true value for all of its users. The partnership connects the Estonian Genome Centre, Department of Computer Science at the University of Tartu, Social Ministry, Health Insurance Fund, Health and Wellbeing Technical Competence Centre, National Institute for Health Development, Clinical Guidelines Committee, the clinical community and patient interest groups. The interdisciplinary nature of personalised medicine is a prime opportunity for starting to break down the traditional silos of healthcare and arrive at a holistic approach that takes the whole human into account throughout the lifecycle.

Ultimately, Estonian personalised medicine is driven by patient-centrality and transforming the healthcare system into a preventative rather than a curative one. From a digital innovation perspective, patient-centrality demands a strong focus on usability, which the Estonian

government is supporting in partnership with Norway Grants and the technology start-up community. On October 15th, 2018, the first funding call was announced for start-ups to build products and services in personalised medicine. The focus is on co-designing with the end-user, to ensure optimal usability and buy-in from the end-users. There is an opportunity to build for health professionals, as well as patients within the scope of this funding and interest has been high from the start-up community in Estonia and abroad. Involving private sector stakeholders is another route to breaking down silos in the healthcare system.

Personalised medicine is an opportunity for tackling the global concerns of chronic disease, ageing populations and rising healthcare costs. It has the potential to deliver health information tailored to each patient at any given point in their lifecycle, thus empowering each individual to assess, track and intervene in their own health and disease experience. Estonia is committed to realising this potential and improving the health and wellbeing of its citizens. ■

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# What is the scale of ambition for the devolved healthcare system in Surrey?

Surrey Heartlands' Director of Transformation, Sarah Parker, and Executive Director of Public Health Helen Atkinson speaking at the [Local Government Partnership Network](#) event discuss the challenges Surrey Heartlands faced as a partnership and their role in supporting a whole system in a successful journey towards a devolved health and social care system

Our experiences of reviewing, developing and commissioning services ensured we had some understanding of whole system change and the key ingredients of building relationships, developing trust and clarifying the end state vision. However, I'm not sure we could ever have been truly prepared for the opportunity, complexities and sheer scale of creating a devolved integrated health and care system.

We are both humbled and energised by being part of a team supporting this move towards devolution. Surrey Heartlands Health and Care Partnership are on a journey to change our culture. Much of that will focus on tackling the reasons for variation in care and outcomes that can be avoided, as well as working as a whole system to plan priorities and remove barriers that are inadvertently getting in the way. These include historical ways of managing money by area or organisation rather than as a whole system. We work with and across the 11 organisations in our partnership on this, with a focus on 14 specific transformation workstreams that will improve health and care outcomes. Our jobs include both nudging and active leadership approaches to continually support and challenge the partnership membership. This is no easy task. We have overcome mountainous challenges as a partnership to achieve such success so far, and this is just the start. We realise and advocate the vast potential of this strategy with every step forward.

The 2012 Health and Care Act started a shift in focus towards collaboration, but the significant accelerator to this journey was from NHS Planning Guidance in 2015. It told NHS organisations and local authorities in England to work together and develop 'place-based plans' for the future of health and care services in their

area. This led to 44 sustainable transformation partnerships forming, some of which today are developing into Integrated Care Systems – including ours in Surrey, which is also supported by a devolution deal. This was only possible in Surrey because of the active support of our local authority and the determination of all the health organisations to face the challenges and opportunity square on. We had strong relationships but the cultures of competition and protective organisational silo working meant this has been – and still is – a complex journey.

## Initial hurdles overcome with diplomacy

Despite the close relationships between organisations in the new partnership, there were still hurdles to overcome together. Diplomacy was the name of the game in the early stages. Healthcare and local government organisations did not have the same ways of thinking, the same culture, the same priorities or the same relationship with their public.

## Funding to create a new culture

Funding was a particular area of sensitivity, with questions surrounding where the money would come from and who was best placed to spend it. The experience of shifting money through the Better Care Fund had not gone well in Surrey and had in fact fostered resentment and distrust. This time we wanted to start thinking differently. Challenges like this gave way to some very difficult conversations and some tough discussions. The first thing we all focused on – and it's something that we still focus on today – was understanding each other better, truly signing up to a shared vision and adopting a set of values and principles that change the culture of how we work. The second thing was how to spend transformation funding we received through



our devolution deal money – looking at opportunities across the system. Members of the partnership remain accountable to their individual organisations but also work together as a system in the best interests of our citizens.

It has sometimes been difficult to get organisations to ‘buy in’ to the partnership, to give more than lip service. We had discussions and even lock-in sessions to help everyone understand the values they would need to demonstrate to benefit citizens. This all led to a memorandum of understanding. Now, we call each other out on our behaviours. We work as a partnership, which is vital to making a devolved care system a success.

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**“The 2012 Health and Care Act started a shift in focus towards collaboration, but the significant accelerator to this journey was from NHS Planning Guidance in 2015. It told NHS organisations and local authorities in England to work together and develop ‘place-based plans’ for the future of health and care services in their area.”**

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This approach has been of great benefit to everybody involved. The NHS has been able to share the effect of policy on patients, while the local government has broadened the agenda beyond purely clinical health pathways to a focus on the wider determinants that impact on health outcomes. All of this was a response to huge financial constraints. It could have been damaging, but it has strengthened us instead.

### **Devolution for evolution in patient care**

So why did we choose to aim for a fully devolved system? Why was the old method not working for us? Well, in short, it was a disconnect between different parts of the system at large. We were working in silos. There was no joint effort. Often patients could leave acute care and ‘slip’ through the net or be stuck in hospital unnecessarily.

What we aim to do now is to bring the vision together. We need to finalise the agreement to leave some of our old organisational allegiances behind – again, it’s the need to function with a single culture. Decisions that used to be made solely by one organisation now need to be made collaboratively. For example, we think about how we could plan together and cross-subsidise where needed in the development and accessibility of electronic shared care records and digital innovation.

### **Together means together – governance to support us**

We have set up a joint commissioning committee, a Partnership Board and have a single system operating narrative. We are looking at aligned and pooled budgets, and joint intelligence systems. We are developing integrated care partnerships to deliver care at place and considering how we integrate for things we want to do at scale. Our aim is truly to function as a fully integrated system.

Encouraging awareness of each other is one of the most beneficial things the organisations are focusing on right now. A recent Royal College of Physicians report has said that 1 in 10 journeys in England are healthcare related. Of course, these journeys have an impact on traffic congestion and poor air quality, which exacerbates poor health in people with asthma and other respiratory conditions. We are starting to recognise the links between policy and citizen health. Thanks to the information shared about this issue, innovative solutions like Skype appointments between patients and doctors are being explored. This is where technology comes into play as a major area of focus for us. Without ambitious steps in introducing technology, progress like this would not be possible.

So, where do we go from here? We’re excited to see where a devolved health and care system will take Surrey Heartlands. Having seen the positive changes we’ve introduced so far, we are keen to take this collaborative effort further, continuing our hard work to improve citizens’ lives. ■

**Sarah Parker**  
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# Paediatric haematology research in the UK: Starting at the beginning

Why starting at the beginning is so important in paediatric haematology research in the UK is a point impressed on us by Dr Sujith Samarasinghe at Great Ormond Street Hospital, London and Grazina Berry, CEO of the Aplastic Anaemia Trust

**T**he current landscape in paediatric aplastic anaemia research and treatment in the UK is quite complex. Huge strides have been made in the treatment of children with the rare bone marrow failure across 20 + treatment centres, primarily via bone marrow transplantation in acquired cases of AA or immunosuppressive therapy. This has helped build an excellent reputation for successful treatment of children with aplastic anaemia, both acquired and inherited, at key centres in the UK including Great Ormond Street Hospital, St Mary's Hospital in London, or in Newcastle, Manchester, Birmingham and other major treatment centres, as well as beyond.

However, what's been lacking is answers to some fundamental yet basic questions:

- What is the prevalence and incidence of childhood aplastic anaemia in the UK?
- What are the numbers of constitutional versus acquired, very severe, severe and moderate cases?
- What are the outcomes of different treatment options and what might the Quality of Life measures tell us about the experiences of children and families dealing with the disease?



changes that the entire family has to brace itself for, in preparation for and during a lengthy, exhausting and expensive treatment, recovery and transition back to a new normality.

A mum of a 15-month old baby diagnosed with AA says: "We didn't understand at first why we went straight to transplant. We didn't know there may have been other treatment options".

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**"The current landscape in paediatric aplastic anaemia research and treatment in the UK is quite complex. Huge strides have been made in the treatment of children with the rare bone marrow failure across 20 + treatment centres, primarily via bone marrow transplantation in acquired cases of AA or immunosuppressive therapy."**

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According to Dr Samarasinghe, the benefits of the study to the UK paediatric haematology as well as the patient community will be significant, as he explains in his own words "We'll have a much better understanding of the causes of AA. This could lead to the discovery of novel genes that lead to childhood aplastic anaemia. We'll also be closer to understanding the role of the immune system in acquired childhood AA. In addition, we will obtain a much deeper understanding of the lived experience and psycho-social impacts of these rare conditions on these patients' wider lives". ■

These and many other questions will be answered by a brand new research project to establish UK's first paediatric bone marrow failure registry and biobank starting in 2019 and led by Dr Sujith Samarasinghe at Great Ormond Street Hospital in London, who is working collaboratively with colleagues in Manchester, York and Oxford University. Funded by the Aplastic Anaemia Trust over a three-year period, the project will enable the collection of a range of data from 30 newly diagnosed patients per year, including chromosomal breakage results, telomere lengths, molecular genomics results, first-line treatment received and subsequent outcomes.

The parents of children diagnosed with aplastic anaemia, a rare and life-threatening auto-immune disease, face huge uncertainties in terms of diagnosis, treatment and recovery pathway currently. This is in addition to a hefty emotional trauma, significant life

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# Red blood cells meets physics. Physics meet red blood cells

Professor Anna Bogdanova, University of Zurich, explores the relationship between red blood cells and physics, in this in-depth analysis

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According to Wikipedia, biophysics is an interdisciplinary science that applies approaches and methods traditionally used in physics to study biological phenomena. Due to their seemingly easy access and handling, red blood cells have been among the first primary human cells that have been biophysically investigated. Nowadays a great variety of laboratory methods regularly applied to red blood cells by biologists and clinicians can be regarded as biophysical methods: patch-clamp, flow cytometry, atomic force spectroscopy, all kinds of microscopy including electron microscopy and scanning microscopy methods, just to name a few. Physicists, in turn, increasingly aim to describe biological objects making extensive use of red blood cells because their composition is in some aspects less complex than of other cells. This approach is often referred to as 'Biological Physics'.

What is obvious for biologists, many physicists still need to digest, that cells including red blood cells are not constants but variables that change continuously and readily adapt to variable external conditions! Vice versa, for physicists it is obvious that also red blood cells create so-called collective phenomena, i.e. in a group red blood cells behave differently than

individual cells, something many biologists need to adapt to.

These examples show the requirement for real interdisciplinary work as carried out in the EU-innovative training network RELEVANCE, where not only biologists, physicists and biophysicists collaborate, they also join forces with clinicians and engineers to progress in the basic understanding of the fascinating red blood cells. The team can then directly apply the obtained knowledge for substantial improvements in societally relevant fields, like diagnostics and therapy of red blood cell-related diseases, in transfusion or sports medicine.

## Gravitation and mechanics

Within the consortium, both classical and very advanced innovative physical approaches are used to analyse red blood cells. For example, we are utilising techniques based on what nature has perfected over billions of years – gravity! It has been found possible to separate a whole population of red blood cells into fractions of young, mature and old cells based on the differences in their density (A). This is done by spinning the cells down the viscose matrix which is dense at the bottom and less dense at the top.

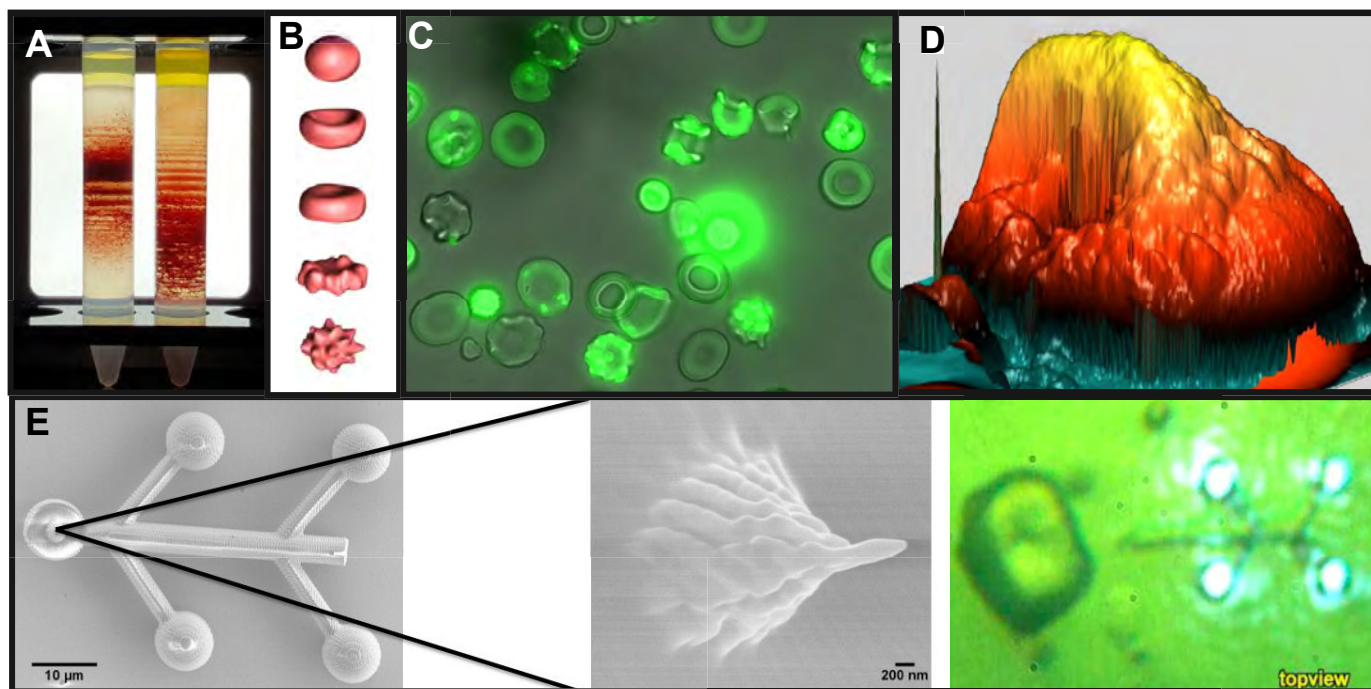
Dense, old or injured red cells move

further and band lower within this gradient, whereas young or pathologically swollen cells form a band at the top of it (A). The distribution of red blood cells within the density gradient differs for healthy controls (A: left sample) and patients suffering with rare anaemias (A: right sample). Fractionated young, mature and aged, or malformed and diseased (B, C) red blood cells may be then collected for in-depth investigation. Even small fractions of dense or rigid and unstable cells that are not flexible enough to squeeze through the small capillaries in our body may cause occlusion and damage to our blood vessels.

How high is the risk of such pathologies, how many dehydrated or rigid cells flow in our veins? The prototype of mechanical and chemical modulator under development by Epigem Limited in collaboration with the team from the University of Zürich makes it possible to answer this question. It combines exposure of red blood cells flowing through microfluidic channels to mechanical or chemical stimulation comparable to those they experience in our bloodstream and visualises responses of individual cells to stressors.

## Electricity

Precise control over electric current



makes it possible to visualise the activity of ion channels, special pores with gates formed by proteins incorporated into the cell membrane. An opening of the gate is detected as a burst of electric current through the membrane. One more way to use electricity for detection of red blood cell volume using impedance and fine details of membrane surface architecture is to use scanning ion conductance microscopy that makes a single living red blood cell with its dynamic oscillating membrane look like a gigantic rock (D). Similar pictures were earlier on obtained only for fixed, dead cells, using electron microscopy. Analysis of such images may help to predict the causes of red blood cell membrane instability and analyse aberrations in its structure.

## Optics

Light-based technologies are extensively used to study red blood cells. Among them are brightfield and fluorescent microscopy (C), and flow cytometry, that are commonly used to visualise gross morphology and localisation of distinct membrane components. Understanding the physics of red blood cell shapes requires high image quality, when

possible in 3D, and a great deal of computer modelling (B). Rapidly developing, physics provides biologists with fascinating nanoscale light-based microscopy – now by experts coined ‘optical nanoscopy’ in celebration of the 2014 Nobel Prize in Chemistry that can already today surpass the classical far-field diffraction limit and provide optical resolutions down to a few nanometers.

Light may also be used for picking up red blood cells of our choice, separating them from the rest of the cells and shepherding them to a place where further in-depth investigations with the selected cells will be performed. This selection utilises the gentle catapulting powers of the laser beam as originally demonstrated by the Nobel Prize winner in Physics 2018 Arthur Ashkin at Bell Labs. For red blood cells of patients, that are hypersensitive to light and heat of the laser beam, a special nano-robots manipulated by light may take over injecting, pushing and pulling as well as capturing functions (E). This brand new field of science has been coined Light Robotics and was invented by engineers from the Technical University Denmark and OptoRobotix ApS.

All in all, this is a very interesting time for the expansion of red blood cell knowledge and the further research of these new methods of detection and screening of red blood cells will be of great benefit to society. Such knowledge may only be generated by interdisciplinary teams of researchers that develop a common language, clear for physicists, biologists and clinical haematologists. Joining such teams as RELEVANCE consortium provides optimal conditions for young specialists to grow into the “next generation” of experts.



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# GDPR in biobanking for precision medicine research: The challenges

R.T. Lawlor, Z. Kozlakidis and M. Bledsoe from the International Society for Biological and Environmental Repositories chart the challenges posed by the General Data Protection Regulation (GDPR) in biobanking for precision medicine research through the sharing of samples and data

**B** iobanks are essential infrastructures fuelling scientific breakthroughs in precision medicine and leading to new treatments. Biobanks collect and provide research-ready, high-quality samples (blood, tissue, fluids) together with associated clinical data. The last two decades have seen sustained growth in the creation of biobanks and biobanks now exist in almost every country.

However, several preconditions are essential to carry out biobank research effectively: the availability of a sufficient quantity of high-quality samples and data, together with funding and importantly a framework for sharing samples and data potentially across many borders. This article provides a first glance at some of the challenges posed by the General Data Protection Regulation (GDPR) to biobanking and approaches to address those challenges.

The GDPR, 2016/679, is the new, EU-wide legal framework for the protection of personal data and became binding in its entirety and directly applicable in all EU Member States in May 2018.<sup>1</sup> Its purpose is to increase the protection of personal data of European citizens and to reduce the legal fragmentation, complexities and uncertainties that existed between the different EU Member States on this matter. Transparency and accountability are emphasised once more as the main principles in terms of data protection.<sup>2</sup>

The GDPR provides both general rules applying to any kind of personal data processing and specific rules applying to the processing of special categories of personal data, including data concerning health and genetic data. Importantly, definitions are provided for what is meant by the terms: 'data concerning health',

'genetic data', 'biometric data', 'anonymous data', and 'pseudonymisation'.

Additionally, the GDPR includes a new definition for the 'consent' term which must be explicit, clear and unambiguous but this can be expanded to certain areas of scientific research when in keeping with recognised ethical standards. The GDPR explicitly contemplates that pseudonymised data remains personal data if the key to the data is maintained anywhere in such a way that the data could be re-identified.

The GDPR requires an additional basis for the processing of special categories of personal data, for example, data concerning health, genetic data, race/ethnic origin. The regulation indicates in its recitals that personal data concerning health also includes all data derived from testing on biological samples and such data is, therefore, included in these special categories. The additional bases for processing special categories of data include explicit consent, processing for reasons of public interest in the area of public health, and processing necessary for scientific or historical research purposes.

GDPR provides derogations for the processing of personal data in the context of scientific research, including clinical and translational research areas, circumventing the need for informed consent. This is subject to technical and organisational safeguards to ensure the rights and freedoms of data subjects and, in particular, the principle of data minimisation (processing only what is relevant and necessary in relation to the research question).<sup>2</sup> Of note, what is lawful under the scientific research derogation could differ among the 28 EU Member States as the GDPR,





by deferring to the national legislatures, accommodates various scientific research-related data collection practices.

### **The view within**

Clinical research biobanks are expected to be heavily affected by the GDPR because they collect, process, store and distribute human biological material, together with associated data, including sensitive genetic and health data. Moreover, they often provide such material and information for the broad sharing of research purposes.

Privacy protections and data security measures have been used in biobanks for a number of years, through existing national regulations. Biobanks have to adhere to strict sets of regulations for both sample uses and data protection purposes. Although biobanks have used ethics committees and IRBs to provide guidance and approval for informed consent, sample and data usage, the GDPR does not consider the opinion of IRBs as a mechanism to process data.

Furthermore, the GDPR introduces new operational requirements for the collection, use and transfer of personal data that may be held by biobanks. It is likely that EU hospital/university/disease biobanks would need to appoint a Data Protection Officer, to monitor compliance with GDPR,<sup>3</sup> given that they process samples and data in a systematic manner and their processing includes special data categories.<sup>4</sup> Data protection officers, whether or not they are an employee of the biobank or the academic institution within which the biobank is located, should be able to perform their duties and tasks in an independent manner.<sup>5</sup>

Of particular importance for biobanking and research collaborations, the GDPR has a broad territorial reach. The GDPR applies to the processing of personal data of all European citizens regardless of where this takes place, therefore, extending the “reach” of the regulation beyond the EU borders.

### **The ripple effect on the rest of the world**

The GDPR is likely to have a major impact outside of

*Continued on page 27 →*

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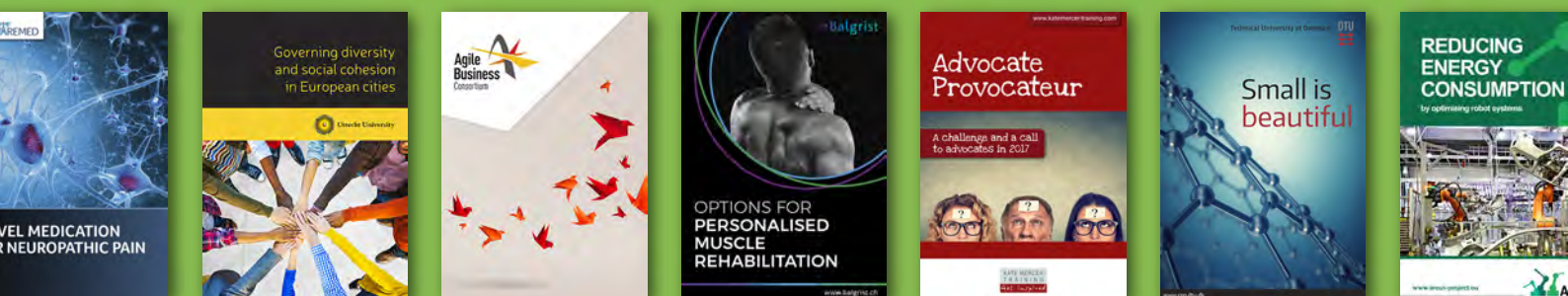
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the EU, where biobanks support multinational studies involving personal data held by entities within the EU or data from EU citizens. The GDPR requires that the high standard warranted by EU law is expanded to collaborative research institutions outside the EU for biobanks involved in international data transfer and research purposes who would be now obliged to follow the GDPR. In addition, personal data processed in the EU from third country citizens would also have to respect these requirements for processing.

According to GDPR, personal data may be transferred to a third country outside the EU which is deemed to have an adequate level of protection. While there are a number of countries that have existing legal data protection structures deemed to be equivalent by the European Commission, there are many countries currently participating in international collaborations with European countries that do not, including the U.S. and African countries.

For countries without this adequacy decision, additional legal bases are required for the transfer of personal data from the EU. Other measures are available but are not particularly amenable to biobanking and research collaborations. The GDPR has introduced two new mechanisms for international transfers, certification and the code of conduct. These incorporate additional layers of approval and as new mechanisms, they will take some time to evolve. Other measures, such as standard contractual clauses exist but are not “research-friendly” and easy to apply in a research/biobanking setting. This last option could be to bring the use of material transfer agreements into the GDPR fold, but this would require adoption either directly by the European Commission or by a supervisory authority in accordance with the consistency mechanism and then adoption by the Commission.

Several efforts are underway in the biobanking and research communities to respond to these challenges, including short-term approaches, such as those identified above, and the development of Codes of Conduct, which will provide further refinement on the implementation requirements for biobanking and

research.<sup>6</sup> Overcoming the challenges of implementing the GDPR will be critical to ensure that important research needed for the development of precision medicine can proceed. ■

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- (2) Article 5.
- (3) Article 39, paragraph 1.
- (4) Article 37, paragraph 1.
- (5) Recital 97.
- (6) <http://code-of-conduct-for-health-research.eu/>

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## Eye health progress and impact: Protecting and prolonging vision by research

To mark its 50-year anniversary, the National Eye Institute (NEI) takes stock of its progress in advancing vision research and developing new therapies to treat blinding diseases

**T**he National Eye Institute (NEI) was established by Congress in 1968 with an urgent mission: to protect and prolong vision. At the time, millions of Americans were going blind from common eye diseases and facing isolation and a diminished quality of life.

Over the past 50 years, public investment in vision research has paid remarkable dividends. Research supported by NEI and conducted at medical centres, universities, and other institutions across the country and around the world – as well as in laboratory and clinical settings at NIH – has led to breakthrough discoveries and treatments.

Today, many eye diseases can be treated with sight-saving therapies that stabilise or even reverse vision

loss. NEI-supported advances have led to major improvements in the treatment of glaucoma, uveitis, retinopathy of prematurity, and childhood amblyopia. We have more effective treatments and preventive strategies for age-related macular degeneration and diabetic retinopathy. Recent successes in gene therapy and regenerative medicine suggest the future looks even brighter for both rare and common eye diseases.

Basic research has revealed new insights about the structure and function of the eye, which also offers a unique window into the brain. In fact, much of what we know about how the brain works come from studies of the retina. Decades of NEI research on retinal cells has led to fundamental discoveries about how one nerve cell communicates with another, how sets of cells





*Paul A. Sieving, MD, PhD, NEI Director*

organise into circuits that process different kinds of sensory information, and how neural tissue develops and organises itself.

People with vision impairment can take advantage of assistive technologies that can help them work, read, navigate their home or city and otherwise remain productive. Many of these technologies have been developed with NEI funding. Ongoing research continues to improve the available options – from prosthetic devices to prism glasses to electronic navigation aids.

This is a remarkable time of discovery. We can view the functioning eye in greater and greater detail and gain a better understanding of the biology, at the level of cells, genes and proteins, that make vision possible – and how things can go wrong with disease or trauma.

In 2012, I challenged our advisory body, the National Advisory Eye Council, and the vision community to identify a novel and ambitious goal that pushed the boundaries of vision science and tackled the most devastating and difficult-to-treat eye diseases. The resulting NEI Audacious Goals Initiative (AGI) gathered

a set of targeted proposals with the overall goal to “restore vision through the regeneration of neurons and neural connections in the eye and visual system.”

Regenerative medicine is a new frontier in biomedicine that uses stem cells, engineered biomaterials, and gene editing to repair, replace, or regrow damaged cells, tissues, or organs. AGI builds on the understanding that many leading causes of blindness, such as age-related macular degeneration, diabetic retinopathy, and glaucoma, result from the death of photoreceptor cells and ganglion cells (neurons) in the eye.

In the eye and brain, lost and damaged nerve cells must be replaced and coaxed to grow long connections to other nerve cells. This complicated process requires scientists to understand not only biochemical guidance cues but also how to train the visual system to form the right connections. AGI will greatly influence regenerative approaches to eye diseases, as well as to other neurodegenerative diseases, such as Parkinson’s disease and Alzheimer’s disease.

AGI is designed to be nimble and responsive to rapidly evolving scientific opportunities to reach its goals. It will take a lot of planning, with input from a variety of experts, to be successful. As a first step, NEI assembled several research consortia to tackle the most pressing needs and gaps in science. The first goal is inventing new, noninvasive imaging technology to watch cells grow and form connections over time in animals and, ultimately, in patients responding to therapy.

Other AGI consortia are trying to identify new regeneration factors that may be turned into therapy and to create new models to evaluate the survival of regenerated neurons and cells. Through this initiative, with continuous input from the research community, NEI is supporting the cutting edge of vision science and beyond. ■

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# Diabetic retinopathy research and thioredoxin-interacting protein (TXNIP)

When it comes to the field of diabetic retinopathy research, Dr Lalit Pukhrambam at Wayne State University is exploring ways to prevent blinding eye diseases due to diabetes by targeting a protein called thioredoxin-interacting protein (TXNIP). Gene therapy is, therefore, a promising option

**B**y way of an introduction, diabetic retinopathy (DR) is a devastating eye disease causing blindness; yet, there is no cure. Thioredoxin-interacting protein (TXNIP) is strongly induced by high glucose and inhibited by insulin. Therefore, chronic hyperglycaemia-induced TXNIP expression in tissues remains elevated in diabetes. TXNIP inhibits the anti-oxidant and thiol reducing the capacity of thioredoxin, thereby, causing cellular oxidative stress, inflammation and cell death. Gene therapy targeting TXNIP is one way to prevent DR.

## **TXNIPlogy: The study of the role of TXNIP in health and disease**

### **Diabetes global epidemic**

Diabetes mellitus (DM) is a metabolic disease in which high blood sugar level persists over a prolonged period. Two main types of DM are Type 1 (insulin-dependent or juvenile diabetes, an autoimmune disease, ~10%) and Type 2 diabetes (insulin-resistant or adult-onset diabetes, associated mainly with obesity and lifestyle change, ~90%). DR is a severe complication of diabetes causing damage to retinal microvasculature and neurons. It can eventually lead to blindness. DR affects up to 80% of all diabetic patients who have had diabetes for 10 years or more. DR accounts for ~12% of all new cases of blindness each

year in the United States and is the leading cause of blindness among the working adult population.

With a global increase in diabetes, obesity and hypertension (*Diabesity*, a term I coined for risk factors for DR), the number of people affected by DR will increase in the coming years. Therefore, there is an urgent need for cure or methods to prevent diabetes and its complications.

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**“Diabetic retinopathy DR is a severe complication of diabetes causing damage to retinal microvasculature and neurons. It can eventually lead to blindness. DR affects up to 80% of all diabetic patients who have had diabetes for 10 years or more.”**

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### **TXNIP and diabetic retinopathy**

Diabetic retinopathy has been defined by complications of retinal microvascular capillaries due to blood vessel leakage/blockade and the development of new and fragile blood vessels (neovascularization). Early DR involves non-proliferative DR (NPDR), which progress to a more serious disease of proliferative DR (PDR). Laser coagulation, anti-inflammatory steroid and anti-VEGF antibody injection into the vitreous are current treatment methods.

However, these treatments do not produce satisfactory results for most

patients. Therefore, there is an unmet need for developing effective therapies via the identification of new gene targets and metabolic pathways. Currently, it is recognised that microvascular damages are late pathologies in DR and there is an early neuronal injury. This is where new therapeutic methods need to be targeted in the early stages of DR, as diabetic eye diseases develop after a prolonged exposure to hyperglycaemia and diabetes duration. Most common retinal cell dysfunctions (including neurons, glia, pigmented epithelium, pericytes and endothelial cells) in hyperglycaemia and/or hyperlipidaemia involve oxidative stress, mitochondrial dysfunction, low-grade inflammation and premature cell death.

Recently, we identified TXNIP as a gene strongly induced by diabetes and high glucose in retinal cells causing oxidative stress, mitophagy dysregulation and inflammation. Knocking down TXNIP by small inhibitory RNAs (RNAi) in the retina prevents early abnormalities of DR, which include capillary basement membrane thickening, glial activation, and neuronal injury. Therefore, we proposed that TXNIP itself and/or its downstream partners, including the NLRP3 inflammasome, are potential targets for gene and drug therapies.

Furthermore, we showed that the

TXNIP promoter exists as an opened and poised configuration that it is activated strongly by high glucose and histone deacetylase inhibitors (HDACi). Therefore, this TXNIP promoter may be operably linked with a therapeutic gene or RNAi to increase/decrease gene expression in diabetes, DR and age-related neurodegenerative diseases.

## Nucleic acid constructs containing a TXNIP promoter for gene therapy

As mentioned above, TXNIP is induced by high glucose and diabetes in most tissues tested so far, including pancreatic beta and retinal cells. Therefore, the TXNIP promoter may be linked with a therapeutic gene or an RNAi and induce their expression under hyperglycaemia, such as encountered in diabetes or after a meal. In particular, the TXNIP promoter may be operably linked to a gene encoding as follows:

- (i) Insulin or an insulin promoting protein (PDX1);
- (ii) A protein that reduces oxidative stress, inflammation and cell death (Trx1 or Gpx4);
- (iii) An RNAi that reduces expression of a protein, which promotes oxidative stress, inflammation and cell death (including TXNIP itself and NLRP3); or
- (iv) A neurotrophic factor (BDNF or GDNF).

Advantages are that the TXNIP promoter will remain active when hyperglycaemia prevails; while mostly unresponsive under physiological glucose.

## Gene delivery

Gene delivery into the retina may be achieved by packaging the TXNIP promoter-gene construct into an appropriate vector, such as recombinant adeno-associated viral vector, rAAV2. The eye provides an exceptional opportunity for gene therapy because it is a closed organ and relatively an immune privileged site. Therefore, cross-contamination from an intravitreal injection to another organ or systemic immune response will be minimal. Additionally, genetic material needed for the retinal gene therapy is small (cost effective) compared to a systemic gene delivery for other organs.

In fact, most current trials in human gene therapy are conducted for retinal diseases, e.g., retinitis pigmentosa. Gene therapy using the TXNIP promoter is simple, yet innovative, potentially mitigating DR progression. Furthermore, gene and tissue bioengineering methods may be applied in ex vivo systems using autologous adipose-derived stromal stem cells (ASCs) or inducible pluripotent stem cells (iPSC) to produce insulin via a TXNIP-promoter-linked insulin gene expression and subsequent subcutaneous transplant of the manufactured cells. These autologous cells, if producing insulin under hyperglycaemia, will avoid immune responses and survive longer in their own subcutaneous environment, as opposed to a pancreatic beta cell transplant.

## Conclusion

Diabetes and its complications affect, not only individuals but also families directly and the society at large. One in ten people in the world is consid-

ered to have diabetes, yet many are to be diagnosed. The loss in work productivity and economy due to chronic diabetes diseases are enormous. Tinkering with simple, yet innovative, ideas may lead to diabetes cure and/or prevention of organ damages. There are promises in the horizon for gene and cell therapy for curing diabetes or preventing DR. TXNIP may be an answer.

## Supports

American Diabetes Association  
Juvenile Diabetes Research Foundation  
Mid-West Eye Banks  
National Kidney Foundation  
National Institutes of Health  
Research to Prevent Blindness (RPB)



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# How can we make eye screening services more available?

Our eyes are considered the most important sense, according to OPTOMED. Here, the firm explains that even though most of us recognise the importance of our sight, many of us are not aware of the importance of systematic eye checks and we are not protecting this valuable sense well enough

**M**ost people value sight above all other senses. Numerous studies have shown that vision impairment is often associated with various negative health outcomes and poor quality of life<sup>1</sup>. Still, approximately 1.3 billion people globally live with some form of vision impairment<sup>2</sup>. Studies have shown that 80% of all vision impairment is considered avoidable by early detection and appropriate treatment.

Additionally, WHO has estimated that diabetic retinopathy is responsible for 4.8% of global blindness.<sup>3</sup> Clinical studies spanning more than 30 years have shown that appropriate treatment of diabetic retinopathy can reduce the risks by 90%<sup>4</sup>. Thus, provision of effective and accessible eye care services is key for controlling visual impairment including blindness<sup>5</sup>.

## The need for mobile eye screening devices

Optomed Ltd was founded in 2005 to meet the challenge of more accessible and affordable eye screening devices. Seppo Kopsala, the CEO and founder of Optomed states: "In the time when Optomed was established, retinal examinations and eye screening was performed mainly on hospital level. The service was not available in rural areas, low-income countries or with patient groups that are not able to

travel and sit in front of a tabletop fundus camera. This poor access to eye examinations was the reason why we started developing a portable, hand-held fundus camera so that the service would be available to all individuals worldwide and we could help health-care professionals to prevent blinding eye diseases by early detection."

Today, Optomed is a world-leading manufacturer of hand-held fundus cameras and screening management solutions with distribution in over 60 countries globally. Optomed cameras are being used by major public hospitals, primary care centres, private clinics, non-government and charity organisations around the world. Optomed's camera is also listed on the standard list of The International Agency for the Prevention of Blindness, IAPB.

In 2017 Optomed launched its newest camera, Optomed Aurora, which was developed keeping in mind company's mission of preventing avoidable blindness even in economically and geographically demanding regions. Optomed Aurora was built to optimise accessibility, connectivity and battery-technology so that fundus imaging services could be transferred from hospitals and specialised clinics closer to populations who would otherwise not have access to routine eye-checks.



This shift can have great influence on the population-wide eye-health as well as on the overall healthcare expenditure.

## Eyes are a gateway to examining blood vessels

Blood vessels can be observed noninvasively in eyes, so they serve as a window to examine signs of several diseases. Today fundus imaging is routinely used to screen for diabetic retinopathy, and to seek signs of age-related macular degeneration and glaucoma; thus, the typical vision-affecting eye-diseases.

In the recent years, there has been research done to find new ways to exploit retinal images clinically especially within neurology retinal vessels; which can be visualised and quantified



*Optomed Aurora hand-held fundus camera is designed to improve access to eye examinations, which play a key role in preventing blindness*

noninvasively; are being used to study diseases like dementia and stroke in vivo<sup>6,7</sup>.

Further extension on the use of retinal images has been realised by applying artificial intelligence (AI) which enables extracting new data from the images<sup>8</sup>. The data can be used, for example, to predict cardiovascular risk factors; such as age, smoking status and systolic blood pressure; which were not previously known to be present or quantifiable in fundus images<sup>9</sup>.

It is easy to claim that the importance of fundus imaging will increase in the future, thanks to its simplicity, noninvasive characteristics, and the increasing number of feasible applications. The widened application field combined with a clever use of information technology and AI will make fundus imaging pivotal part of the diverse routine and specialised healthcare practices.

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# Diabetes monitoring and drug delivery innovation fields: The scenario for big technology synergy

Cecilia Van Cauwenberghe from Frost & Sullivan's TechVision Group provides a market perspective on the diabetes monitoring and drug delivery innovation fields and explains why these are a scenario for big technology synergy

The diabetes drug delivery market reached over \$67 billion in 2017 and is expected to reach at least \$120 billion by 2022, with a compound annual growth rate (CAGR) of 12.1% from 2017 to 2022. According to Frost & Sullivan studies, inhalable and transdermal delivery present the most impressive growth with a combined CAGR of 27.3%. In particular, inhalable delivery alone exhibits a CAGR of 70.8% for 2015, with an expected global market of \$1.6 billion expected by 2020 (Rajan, 218).

Regarding diagnostics, mHealth monitoring systems account for the greater share by taking up 60% of the market. Large pharmaceutical and medical companies, small and medium enterprises (SMEs) and start-ups led by technology entrepreneurs are envisioning significant opportunities to deliver diabetes care innovations, based on decentralised, point-of-care, artificial intelligence (AI)-driven data, to the market, aiming to promote healthy lifestyles and improve treatment outcomes. Private investors, including venture capital firms, have augmented their investments in such therapeutic areas during the past five years, focusing primarily on digital health. These approaches strongly promote a patient's engagement, thanks to the combination of Big Data analytics and machine learning approaches with smart delivery systems and wearable monitoring devices, committed to precision medicine achievements.

## Innovation scenarios

The innovation scenarios can be categorised as follows (Van Cauwenberghe, 2016):

### Smart therapeutics

Pharma/biotech innovations in: anti-diabetics, alternative route insulins, insulin analogues, diabetes-related diseases and incretin hormones.

Examples are: Afrezza® (Sanofi and MannKind), Tanzeum® (GSK), Xigduo XR (AstraZeneca), Xultophy® (Novo Nordisk), Smart Insulin (Merck) and Bile Acid Microcapsules (Curtin University).

### AI-driven precision medicine

Medtech innovations in: smart insulin pumps, artificial pancreas, glucose monitoring, mobile data analysis, point-of-care devices.

Examples are: FreeStyle® Libre flash glucose monitoring system (Abbott); Contact lens glucose monitoring (Google and Alcon-Novartis); Hidden needles (MIT); Autoantibody measuring chip (Stanford University and IGI Stat); SmartGuard® GlucoSitter Artificial Pancreas Software (Medtronic/DreaMed Diabetes); iLet Bihor-monial Bionic Pancreas (Boston University and Massachusetts General Hospital); ITCA 650 (Intarcia), a matchstick-sized transdermal device; and G-Pen Mini™ (Xeris Pharma), a pre-mixed glucagon administrator.



## Technology convergence

Synertech innovations in are: micro/nanotechnology, advanced electronics, implantable devices, 3D tissue printing, cell-based therapies (Buch et al., 2018).

Examples include: Glucose sensors with nanoscale components, such as metal nanoparticles and carbon nanostructures for continuous in-vivo glucose monitoring (University of North Carolina at Chapel Hill); spherical nucleic acids silencing gene that interferes with wound healing (Northwestern University); cell reprogramming via nanotechnology for Type 1 diabetes (Southern Medical University in Guangzhou); engineering  $\beta$ -cell replacement therapy (Mayo Foundation for Medical Education and Research); glucose-responsive insulin-producing liver cells (Orgenesis); and 3-D bio-plotted hydrogel scaffolds for islets of Langerhans transplants (University of Twente, Leiden University Medical Center and University Medical Center Utrecht).

## Smart manufacturing

Novel diagnostics and monitoring systems demand for smart specialisation and open or semi-open manufacturing systems, in order to exploit the huge potential of mHealth, AI-driven systems to accelerate technological progress in diabetes care. According to experts, these combined factors are expected to lead to a cascading effect on the productivity and efficiency of health systems with a technological base (Doupis et al., 2018).

Advanced manufacturing is witnessing an increased amount of intelligent new processes and solutions in the glucose monitoring value chain, therefore, saving costs, reducing time and providing much better quality production (Contreras and Vehi, 2018). This approach directly impacts the whole value chain by offering more flexible, agile and efficient manufacturing processes.

## Final remarks

Demand is increasing for more personalised and precision medicine in diabetes- and cardio-metabolic-related diseases. As a result, diverse elements throughout the biomedical production process are appearing on the scene. Parallel trends in biotechnology, including stem cell therapies, are occurring with the advent of personalised biomarkers which are reshaping the diabetes and cardio-metabolic fields.

Similarly, the combination of advanced diagnostics and monitoring technologies with smart materials and flexible electronics are revealing a very promising synergy. The market is clearly reflecting these investigational trends with the introduction of new commercially-available monitoring, testing, wearables and portable products, many of them behaving as intelligent medical devices. An important acceleration of these trends is expected within the next two years. ■

## Acknowledgements

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# Artificial pancreas systems in Type 2 diabetes: closing the loop in diabetes care

Prof Dr Freimut Schliess, explores how artificial pancreas systems are revolutionising healthcare for Type 2 diabetes patients

In the last ten years, tremendous progress has been made in the clinical validation of automated insulin delivery by means of artificial pancreas (AP) systems for people with Type 1 diabetes (T1D). In Europe, both the MiniMed 670G and the Diabeloop DBLG1 hybrid AP systems were granted marketing authorisation for treating adults with T1D. Clinical trials in people with Type 2 diabetes (T2D) indicated the feasibility and safety of AP systems also in this patient population.

Objectives and scope of AP usage in T2D may vary according to the diversity of people with T2D and their needs and requirements. Introduction of the AP early after diagnosis might facilitate the transition to insulin therapy thereby helping to delay the decline of beta cell function and the onset of clinically overt diabetes complications. People with T2D already on insulin pump therapy might have a particularly positive attitude towards AP usage. For them, the AP could be perceived as a logical and consistent enhancement of insulin pump functionalities. Probably some people on insulin pump therapy will show additional benefit from the transition to an AP system in terms of glycaemic control.

In the management of people with advanced T2D and elderly people with T2D AP usage could be expected to relieve users and caregivers from the

burden associated with insulin administration. Here the AP usage might protect people from frailty, disability, and disease aggravation related to unrecognised episodes of massive dysglycaemia. This could translate into lower rates of avoidable hospitalisations for actually ambulatory care-sensitive conditions – a well-recognised cost driver with a high impact on life quality for people with diabetes and their loved ones.

The pan-European CLOSE consortium<sup>(1)</sup> is aiming to develop integrated AP solutions (APplus) for people with T2D. APplus means a comprehensive product and service package, adding education and training, outcome predictors and performance indicators as well as telemedical services to the AP device. When developing APplus CLOSE follows a co-creative approach in the specific framework of French homecare service provision. French homecare service provider operate fully integrated chronic care platforms at the crossroads between patients, health professionals, payers, and prescribers.

French homecare service provision seems to be a real-world environment particularly suitable as a learning lab for co-creating an APplus solution meeting the needs and requirements of patients, payers and caregiver teams. Here learnings about the different stakeholders' perceptions of diabetes, their attitudes towards

diabetes management, and their understanding of treatment success can immediately inform the customisation of APplus packages.

For a wider distribution of AP usage, it seems reasonable to assume that APplus should be highly adaptable to the requirements of different T2D patient sub-groups and their specific care situations. This calls for an APplus portfolio containing an array of AP systems e.g. with and without carbohydrate counting and realising different intensities of insulin therapy and degrees of automation.

Indeed, APplus has a high potential for massive and multidimensional scalability. Using homecare as a starting point APplus could be expanded to operate in assisted living facilities, nursing homes, and hospitals. Also, APplus solutions for people having T2D without overt comorbid conditions or T1D are under consideration. Geographical upscaling should seek benefit from collaboration with regions and municipalities in a careful consideration of existing local/national competencies, healthcare structures and payment models. An obligatory delivery of train-the-trainer programs would grow a network of certified caregivers guaranteeing a safe and cost-effective implementation of AP solutions around Europe and globally. Beyond technical adaptations, the design of highly targeted training modules is predicted to be the main



differentiator of APplus solutions tailored to the needs and requirements of different patient groups and care environments.

Adding capabilities for the exploitation of patient-generated health and behavioural data will functionally enhance the AP in the medium term. The utilisation of self-learning algorithms and an increased interconnectedness with health and social service providers will close the loop between the users' state of health and customised care provision in a more comprehensive meaning. Converging with other strands of health innovations in chronic care enhanced AP systems will contribute to a fully integrated personalised diabetes management.

From the previous CLOSE investigations into stakeholder attitudes, it became clear that physicians and patients see a high need for a continuous further development of the AP. An AP system focusing on the closed-loop control of blood glucose levels is

considered a transition technology towards a much more comprehensive predictive decision support based on further advanced control algorithms. This scenario matches the outcome of the CDTM Trend Seminar on "Digital Innovation in Diabetes Care" co-organised by CLOSE <sup>(2)</sup>. Here AP operation is predicted to become gradually integrated as part of an interconnected ecosystem of digital health and social care.

A comprehensive monitoring of metabolic signatures and parameters reflecting patterns of everyday behaviour would produce a huge amount of real-world data which could be processed by self-learning control algorithms using artificial intelligence tools. The outcome should trigger an adjustment of therapies, treatments and behavioural patterns which again would feedback to the captured parameters.

Closing control loops and gradually optimising disease management in a

personalised way is going to realise the twin objective of optimising everyday metabolic control and re-adapting behavioural habits to prolong the patient's independence and prevent the development of frailty & disability and comorbid conditions.

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# Bleeding gums: Sentinels of non-communicable diseases of ageing

Professor Iain Chapple from the University of Birmingham UK, explains the link between periodontitis and non-communicable diseases such as Type 2 diabetes

In 1990, the leading causes of non-fatal health loss in males and females, determined by years lived with disability (YLD) were oral disorders. The latest Global Disease Burden analysis of disability life years demonstrates that this remained the case in 2007<sup>(1)</sup>. The global economic impact of dental diseases (principally periodontitis and dental caries) in terms of direct treatment costs are estimated at \$298 billion, or 4.6% of global health expenditure, and indirect costs (i.e. productivity cost) equate to \$144 billion which is within the range of the 10 leading causes of death globally<sup>(2)</sup>.

Periodontitis is a non-communicable disease (NCD) that afflicts 40-50% of adults worldwide, with severe periodontitis affecting 11.2% of adults, being the sixth most common human disease. Periodontitis is a major cause of tooth loss, negatively impacting upon nutrition, speech, self-confidence/esteem and quality of life.

However, it remains poorly reported in the medical world that periodontitis is also an independent and non-traditional risk factor for premature mortality (all-cause and cardiovascular mortality) as well as several systemic NCDs such as Type 2 diabetes (T2D), atherogenic vascular disease (AVD – cerebrovascular and cardiovascular), chronic kidney disease (CKD) and rheumatoid arthritis (RA). Periodontitis shares common risk factors with its sibling NCDs such as smoking,



*Figure 1. Bleeding gums (gingiva) are not normal and may be a sign of periodontitis. An oral examination can determine the cause/prevention of gingival bleeding*

overweight/obesity, glycaemia/hyperglycaemia and stress.

Whilst this provides opportunities for the oral healthcare workforce to support WHO initiatives on common risk factor control, there is also robust evidence emerging that periodontitis is a co-morbidity for NCDs like AVD, T2D and CKD and that successful management of periodontitis can improve outcomes of AVD<sup>(3)</sup> and T2D<sup>(4)</sup>.

The potential importance of periodontitis as a common but silent co-morbidity (Figure 1) was highlighted in a recent study by the Birmingham group, which demonstrated the co-morbid presence of periodontitis in CKD patients with stage 3-5 disease significantly increased all-cause and cardiovascular mortality. The impact of periodontitis was equivalent to that of the co-morbid presence of T2D in CKD patients<sup>(5)</sup>.

Moreover, the multi-morbid presence of periodontitis, T2D and CKD further increased all-cause 10-year mortality by 23% and cardiovascular mortality by 16%. The group have also started to unravel potential mechanisms whereby periodontitis may add to the systemic inflammatory burden<sup>(6)</sup> through the activation of reactive oxygen species release by circulating peripheral blood neutrophils, as well as the activation of an acute-phase response (CRP). These are believed to arise due to the proven entry of periodontal bacteria into the circulation during eating and tooth brushing in those patients with periodontitis, with a dose-response between the severity of disease and magnitude of bacteraemia.

Such events, when arising multiple times daily over several decades are a cause of the chronic low-grade systemic inflammation in periodontitis sufferers

and thus a biologically plausible mechanism underpinning the development and complications of complex diseases like T2D<sup>(7)</sup>.

The strongest relationship between periodontitis and any NCD is with Type 2 diabetes, where a bi-directional relationship exists. The presence of hyperglycaemia in poorly controlled or undiagnosed diabetes strongly associates with a more severe and suppurative periodontitis, and the presence of periodontitis associates with an increased risk for developing T2D, poorer glycaemic control, dyslipidaemia and both microvascular and macrovascular complications of diabetes.

The evidence was recently reviewed systematically by a joint workshop between the International Diabetes Federation (IDF) and the European Federation of Periodontology (EFP) and published simultaneously in the medical and dental literature<sup>(8)</sup>. The joint EFP/IDF workshop produced evidence-based guidelines for patients attending medical and dental practices, as well as for medical and dental teams. Systematic reviews demonstrate that successful periodontal treatment can lower HbA1C levels by approximately 0.4% and a recent randomised controlled trial of intensive periodontal therapy demonstrated a 0.5% difference in HbA1C at 12-months between an intervention group and a control group<sup>(4)</sup>.

Indeed, NHS England is developing a commissioning standard, which supports the recommendation that patients diagnosed with T2D are referred for a periodontal examination and any necessary treatment, and that oral health professionals play a role in early identification of diabetes. The health economic models indicate

savings in medical care costs of up to £124 million if periodontal treatment in dental practice is optimised and a further £48 million savings if diabetes and pre-diabetes are identified early within dental settings.

Screening programmes for NCDs remain controversial, but NICE guidelines support the risk-driven early detection of diabetes in dental care settings. The rationale is that the public attend dental care professionals (DCPs) for “check-up’s” when they are healthy, thereby facilitating preventive programmes and behaviour change, whereas the majority of patients attend their medical practice when they have an ailment.

DCPs, therefore, access a different population to medical professionals and DCPs are experienced and successful in implementing preventive programmes<sup>(9)</sup>. Given the 1 million undiagnosed cases of diabetes in the UK alone and 17 million undiagnosed cases in Europe, this would appear to be a missed opportunity, and one that merits further exploration. Are the public and professions ready for such a change?

A recent study from the Birmingham group sought the opinions of 2919 of the public in the West Midlands, alongside 222 healthcare professionals<sup>(10)</sup>. 48% of NHS dental patients and 61% of private dental patients were in favour of being assessed for NCDs in dental practices, as were 75% of those questioned in community pharmacies. All stakeholders were broadly supportive of allied health professionals performing risk assessments for NCDs like T2D.

Interestingly, 28% (25%) of NHS (private) dental patients questioned had not seen their general medical practi-

tioner (GP) in 12-months and 7% (5%) had not seen a GP in five years. Of these groups, 42% (NHS) and 63% (private) were in favour of NCD assessment in dental practices.

Given that dental care professionals access a different population to GPs; dental providers also access people who do not attend their GP regularly, and periodontitis is a sentinel disease for other NCDs like T2D, it would appear that it is time to put the mouth back into the body and encourage greater collaboration between dental and medical teams.

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## The importance of Type 2 diabetes prevention

Chanelle Corena, Type 2 Prevention Lead at Diabetes UK, highlights the 12.3 million people in the UK who are at an increased risk of developing Type 2 diabetes and precisely why prevention and a change in behaviour is crucial in this vein

**D**iabetes in its various forms costs the NHS £10 billion every year; that's 10% of its entire budget or, more precisely, £1 million every hour. One in six hospital beds in England are occupied by someone living with diabetes. These figures illustrate the pressure already being exerted by diabetes on our NHS.

Across the UK, 3.7 million people are currently living with diabetes, and a further million have the condition but are yet to be diagnosed. On top of this, 12.3 million people are at increased risk of developing Type 2 diabetes, and five million are described as being at high risk. The number of people living with diabetes is growing, having doubled in the last 20 years.

90% of people living with diabetes in the UK have Type 2. As many as three in five new cases of Type 2 are preventable. A greater focus on preventing Type 2 diabetes is essential if we are to begin tackling the diabetes crisis and alleviate the burden diabetes puts on our NHS.

There are various risk factors related to the development of Type 2 which cannot be changed, such as age, gender, ethnicity and your family's medical history. But there are other risk factors that we can modify, like weight, waist circumference and blood pressure.

Weight is the most significant modifiable risk factor for



developing Type 2 diabetes and is associated with 80% to 85% of the risk. The UK is one of the most overweight nations in Europe. If we are serious about curbing the spread of Type 2 diabetes and alleviating the strain it puts on our already stretched NHS, the obesity crisis must be addressed, with a focus on the changing the behaviours that lead to weight gain.

As well as investing in research to better understand unmodifiable risk factors, our work on Type 2 prevention focuses on behaviour change. Behaviour change is achieved both by creating an environment supportive of healthy choices, and by increasing the capability of individuals to eat better, move more and manage their weight.

We welcomed the Health Secretary Matt Hancock's announcement of his new Vision for Prevention in November 2018. We're glad that the Health Secretary has recognised the urgent need for greater focus on preventing chronic conditions, and his highlighting of the fact that £8 billion is spent each year on prevention, compared to £97 billion on treatment, makes clear the need for a greater focus on prevention in the health service.

The Health Secretary will reveal his vision in more detail in a Green Paper in 2019. This is positive news, but we hope the Health Secretary recognises the importance of creating a healthier environment to prevent chronic conditions, as well as individuals living more healthily. Creating a healthier environment must include changes to public policy, such as the Soft Drinks Levy, which encourage healthier living.

Having said this, we do recognise the importance of helping individuals understand their risk and supporting them to make the lifestyle changes necessary to prevent or delay the onset of Type 2 diabetes. In 2017, we helped over 150,000 people understand their risk of developing Type 2 diabetes through our Know Your Risk tool and gave them the knowledge necessary to reduce it.

We have also partnered with Public Health England and NHS England to support 100,000 people with lifestyle interventions through the Diabetes Prevention Programme. But with 12.3 million people at increased risk, this is just the tip of the iceberg and we know we need to do more.

It's vital that government and industry take action to help create a healthier environment, in which the healthy choice is the easy choice. We've been campaigning for clearer, more consistent food labelling through our Food Upfront campaign. We want major food retailers to improve their labelling to help people with diabetes manage their food intake when they're eating out, and also to help people make healthier, more informed decisions about the food they eat.

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**"We welcomed the Health Secretary Matt Hancock's announcement of his new Vision for Prevention in November 2018. We're glad that the Health Secretary has recognised the urgent need for greater focus on preventing chronic conditions, and his highlighting of the fact that £8 billion is spent each year on prevention, compared to £97 billion on treatment, makes clear the need for a greater focus on prevention in the health service."**

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We're also calling on the government to tackle the obesity crisis and help us prevent millions of more people from developing Type 2 diabetes, by introducing a 9 pm watershed on junk food advertising and by restricting price promotions on unhealthy food.

We're excited to see the Health Secretary's Green Paper, setting out specific policies to fulfil his vision for prevention. We hope that the government continues to take the action required to create a healthier environment for everyone in this country and continues to support prevention programmes, like the NHS Diabetes Prevention Programme, to ensure that as many people as possible in future avoid a preventable Type 2 diabetes diagnosis. ■

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# From diabetes prevention 1.0 to Prevention 3.0

Digitally enabled pathway personalisation is leveraging actionable data insights and dynamic intelligence to drive better outcomes as part of the Prevention 3.0 agenda

**W**hen it comes to the case for diabetes prevention, we know that the rising global prevalence of Type 2 diabetes has placed acute strain on healthcare budgets, attracting the attention of US and UK policymakers.

The US National Diabetes Prevention Program established credible evidence linking lifestyle change with reducing risk of Type 2 diabetes onset, leading policymakers in the UK to establish the NHS England Healthier You Diabetes Prevention Programme.

Early provision, or prevention 1.0, was geared to helping those identified with elevated blood sugar levels to create a lifestyle change plan in face-to-face settings.

Prevention 2.0 built on this by leveraging telehealth and nascent digital-enablement to reinforce face-to-face provision with remote support.

## Pushing the boundaries of the possible

Hitachi's diabetes prevention journey started in 2010, when the company developed its first digitally-enabled service to support its employees in meeting their wellness goals. Hitachi's programme attempted to move provision towards telehealth and digital-enablement, or prevention 2.0.

By bringing together a blend of

telehealth coaching and digital tools, Hitachi was able to personalise the provision of care, while giving its employees the means to effectively self-manage their lifestyle changes.

Since 2010, the solution has been rolled out to other Japanese corporates and used as a foundation for Hitachi's collaborations with the NHS in England, aimed at leveraging clinical expertise, remote telehealth and digital solutions to create a new model of provision, or Prevention 3.0.

## Actionable data insights and dynamic intelligence

Hitachi's Smart Digital Diabetes Prevention solution, underpinned by its Prevention 3.0 vision, firmly establishes data as a critical enabler for improving service performance and patient outcomes. Developing an appropriate data lake consisting of cohort, progress and engagement data (to be described in the forthcoming OAG e-book due to be published in October 2018) is the first step towards delivering dynamic intelligence.

The next step is to surface data insights through advanced analytics and combine these with qualitative analysis, using user-centric design methods and a co-creation approach with commissioners, digital teams and frontline NHS health advisers to identify opportunities and strategies for service improvement.

## Service personalisation

Actionable data insights and dynamic intelligence allow Hitachi and its clinical partners to help support personalised service provision, so that appropriate support is provided to patients at the right time. This helps to ensure that patients' needs and preferences drive health adviser engagement and coaching, providing patients with the best opportunity to achieve positive outcomes (reduction in risk of Type 2 diabetes onset), while furnishing the service with the intelligence needed to ensure constrained resources are targeted to those with the greatest need.

Examples of how Hitachi's Smart Digital Diabetes Prevention solution has leveraged actionable data insights and dynamic intelligence to support service personalisation include:

- Personalisation of patients' lifestyle change goals based on cohort and presenting needs data captured through an online self-assessment and processed with algorithms.
- Personalisation of the health adviser dialogue with their patients based on cohort and progress data, such that it focuses in on the greatest areas of need.
- Personalisation of the pathway based on population-level cohort insights, such that patients who require more intensive health adviser

support receive it at the right time, while allowing those who can self-manage do so.

**Hitachi's Smart Digital Diabetes Prevention solution leverages actionable data insights and dynamic intelligence to help support personalised service provision at patient and population level to improve health outcomes and optimise allocation of resources to support defined areas of need.**

## Service improvement

Actionable data insights and dynamic intelligence allow Hitachi to better understand how patients engage with digital tools, allowing an agile continuous service improvement agenda to be implemented. The latter includes enhancement to both the digital tools and the coaching and education delivered by health advisers, to respond quickly to needs identified at population, cohort and patient levels. Examples of how Hitachi has leveraged actionable data insights and dynamic intelligence to support service improvement include:

- Evolving health adviser and patient dialogue from a transactional to transformation dialogue, whereby the dialogue is focused on addressing the individual lifestyle needs rather than a mere description of lifestyle habits, thus ensuring patient support is as personalised as possible.
- Ensuring that minority cohorts (such as those with limited access to digital tools and limited IT literacy) can engage with the pathway and receive additional support where appropriate.

- Evolving the digital tools to promote active patient engagement while in service. This includes the design of new features, auto-generated behavioural prompts and signposting to appropriate and tailored structured lifestyle information.

**Hitachi's Smart Digital Diabetes Prevention solution leverages actionable data insights and dynamic intelligence to enhance the scope and impact of continuous service improvement activity to help ensure that support offered to patients continues to evolve in line with best practice and patients' engagement with the digital service.**

## Commissioning of services at population level

Commissioners at national, regional and local levels are eager to ensure the services they procure address population needs, while remaining flexible to meet needs at more discrete levels. While 'hard' clinical data offered by service trials and clinical studies continues to be the gold-standard for decision-making:

- Commissioning organisations are finding it increasingly difficult to commit both the funding and resources required to deliver them.
- The timescales prohibit rapid delivery of data insights in what is a very fast-moving digital healthcare economy.

This means that commissioners are turning to both qualitative and quantitative data-points established through patients' engagement with digital tools, thereby allowing them to access dynamic intelligence at lower

cost. Hitachi's Smart Digital Diabetes Prevention solution provides data insights that can help commissioners realise these objectives:

- Providing access to dynamic intelligence that identifies opportunities for developing new and integrated services and/or transforming existing service offerings to ensure maximum reach and outcomes for patients.
- Allowing dynamic intelligence to be accessed throughout the service management lifecycle, allowing commissioners to ensure that services evolve with the regional and/or local healthcare economies.
- Informing both the 'hard' and 'soft' metrics commissioners build into future service contracts to ensure they are meeting the needs of their populations at optimal cost.



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# Diabetes and low blood sugar: Taking a more precise approach to managing hypos

James Cotterell, Director at BBI Healthcare, argues that prescribing products that treat low blood sugar with a precise and measured dose of glucose can improve patient outcomes, reduce patient anxiety and save the NHS money

For people with diabetes who have previously relied on sugary food and drinks to treat low blood sugar, the sugar tax introduced in the UK on April 2018, has resulted in confusion and concern.

Managing and preventing low blood sugar is part of daily life for people with diabetes. Most people with Type 1 diabetes have episodes of low blood sugar (when their blood glucose level drops below 4mmol/L) often, around twice a week.<sup>1</sup>

One of the first things people learn after they have been diagnosed is why hypos happen and what to do about them. Common symptoms are: feeling shaky, sweating, hunger, tiredness, blurred vision, pins and needles around their mouth, finding it hard to concentrate, headaches, feeling tearful, increased heart rate, and becoming stroppy or stubborn. When this happens many people with diabetes eat or drink something sugary – for example, a sugary drink, such as fruit juice or an ordinary (non-diet) fizzy drink.

## The sugar tax has implications for people with diabetes

The sugar tax applied to soft sugary drinks, introduced in April 2018, has caused concern amongst people with diabetes. Previously able to rely on the amount of glucose in a bottle of

drink, such as Lucozade, the sugar content in sugary drinks is being reduced by 50%. In real terms, this means that people with diabetes have to consume more of these drinks to receive the same amount of glucose. Another complication is that old and new formulations of these drinks may sit side-by-side in shops during the transition period.

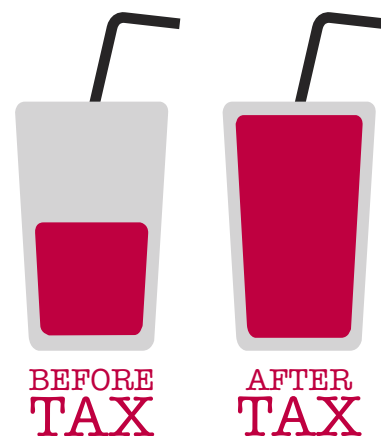
**“The sugar tax may lead people with diabetes to doubt the amount of glucose they are absorbing.”**

Diabetes UK supports sugar reduction, but the charity is aware that these measures have caused concern for people who may use sugary food and drinks to treat low blood sugar. Diabetes UK states: “It won’t always be clear if and when companies have reduced the sugar content of their food and drinks, and they may not publicise any changes. When a company changes the sugar content, there may be a time when both old and new recipes of the same product are on sale at the same time, as the old recipe sells out.”<sup>2</sup>

## Anxiety about low blood sugar is a serious problem for 25% of people with diabetes<sup>3</sup>

Of course, it would be unwise to have no fear of hypoglycaemia at all – it’s a dangerous situation, and fear obviously plays some role in avoiding it.

## REDUCED SUGAR CONTENT



**>50% more required for hypo management**

The effects of low blood sugar can be frightening, embarrassing, uncomfortable, unpleasant, or in their worst cases, fatal. But anxiety and fear about low blood sugar can result in people with diabetes deliberately running blood sugar levels higher than usual, which can result in elevated HbA1c and further complications and costs for the NHS.<sup>4,5</sup> In fact, the majority of diabetes-related conditions such as heart disease, nerve damage and amputation, and vision problems – occur as a result of uncontrolled blood glucose levels, particularly elevated blood sugar over a prolonged period of time.<sup>6</sup>

## Low blood sugar has a significant negative impact on patient outcomes, healthcare resource use, and expenditure<sup>7</sup>

Whilst most hypos are mild, some can be severe. If improperly treated, low blood sugar can cause seizures and result in people collapsing or passing out.

In 2015, the mean cost per hospital admission for severe hypos in England was shown to be £1,034, and it is estimated that severe hypos currently cost the NHS £13 million a year.<sup>7</sup> Effectively managing and treating low blood sugar with a measured and specific amount of glucose could prevent more serious complications and reduce the burden on secondary care.

## Ensure people with diabetes have the right amount of glucose when they need it most

Having access to the right amount of glucose to confidently self-treat and self-manage low blood sugar levels are crucial for anyone living with Type 1 diabetes.

15-20g of fast-acting glucose is recommended to treat a hypo.<sup>8</sup> GlucoGel contains a precise, measured, fast-acting glucose to help rapidly raise blood sugar levels and is recommended by NICE<sup>9</sup> and the Joint British Diabetes Societies (JBDS) for hypo management.<sup>10</sup>

The Gluco range also includes a juice (GlucoJuice contains precisely 15g of fast-acting glucose) and dextrose tablets (GlucoTabs contain 3.7g of fast-acting glucose per tab) which are readily available at pharmacies and provide a measured alternative to the more traditional energy drinks and bars that are used to manage blood sugar levels.



25% ARE

ANXIOUS

ABOUT LOW BLOOD SUGAR

## Conclusion

The sugar tax may lead people with diabetes to doubt the amount of glucose they are absorbing. With anxiety about low blood sugar being a serious issue for people with diabetes, prescribing GlucoGel – a precise and measured dose of glucose – could help alleviate some of this concern and potentially reduce complications and costs arising from people with diabetes deliberately running blood sugar levels higher than usual.

Low blood sugar can result in serious complications if improperly managed, leading to poorer patient outcomes and ultimately increasing the burden on the NHS. An estimated £14 billion is spent a year on treating diabetes and its complications<sup>11</sup>, with the cost of treating complications taking the largest slice of the pie. By prescribing a precise and measured dose of glucose for people with diabetes, and taking a more precise approach to hypo management, we could improve patient care and save the NHS money.

For more information about the benefits of prescribing GlucoGel go to [Getglucogel.co.uk](http://Getglucogel.co.uk)

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**James Cotterell**

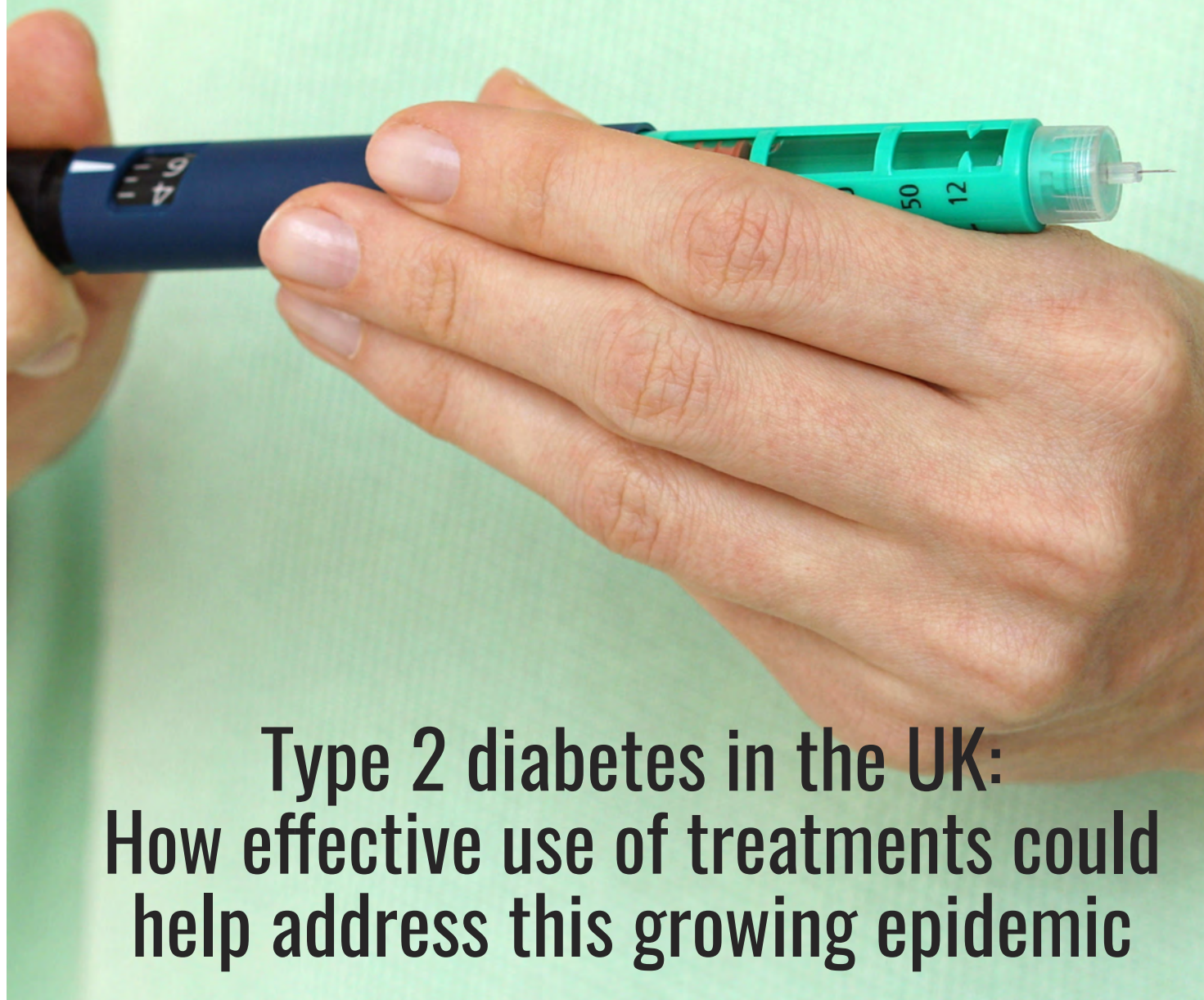
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## Type 2 diabetes in the UK: How effective use of treatments could help address this growing epidemic

Professor John Wilding from the University of Liverpool discusses how more effective use of treatments and greater support for healthcare professionals can make the difference in the battle against Type 2 diabetes

In the UK, there are currently over 3.5 million people living with Type 2 diabetes. Of that number, nearly 7,000 are children and young people under the age of 25 – a figure almost ten times higher than previously thought. Additionally, there are currently 6 million people at risk of Type 2 diabetes in the UK. The National Diabetes Prevention Programme, a recent initiative, is offering support to 100,000 people with diabetes or at risk of the disease to help them reduce their blood glucose levels through an intensive lifestyle change. However, with a further 5,900,000 at risk, the health service faces massive challenges in treating this growing epidemic effectively.

This growing prevalence and earlier age of onset means that healthcare professionals are also contending with increasing numbers of people with a new diagnosis of diabetes. This can create problems as it can be difficult to determine whether a young person has Type 1 diabetes (which requires insulin treatment), or Type 2 diabetes. With limited numbers of specialists and competing time pressures, there is a need for more education in primary care, where most people with diabetes are seen.

Type 2 diabetes is progressive, often leading to complications such as heart disease, kidney damage and



blindness. It is, therefore, vital that people are prescribed the correct medication in parallel with lifestyle support (diet to promote weight loss and increased physical activity). Most patients will need more medications as their condition progresses and should be escalated onto new medications efficiently. This is something that we need to improve upon in the UK. Evidence has shown that when glucose rises above individual target levels, as recommended in current guidelines, the necessary escalation to a second or third medication can take up to two and a half years. To escalate patients beyond this, such as going on to insulin, can take five to six years. These delays lead to a much higher risk of serious complications.

A factor that could be driving this delayed escalation is the lack of access to diabetes specialists. People have different levels of access to expert care depending on where they live in the country. But the reality is that the existing number of diabetes specialists only have the capacity to see 5-10% of people with Type 2 diabetes. There are some local schemes helping to improve diabetes education among healthcare professionals and people with diabetes. The Liverpool Diabetes Partnership (LDP) for example, offers access to specialist teams in primary care settings. These teams are able to support the delivery of quality education, care and support to people with both newly diagnosed and established diabetes. Alongside this, they also help improve diabetes management in primary care, leading to a reduction in complications and expensive hospital admissions. Initiatives such as this, in combination with effective treatment, are vital to tackling the burden of Type 2 diabetes.

## Effective treatments for Type 2 diabetes

In recent years, highly effective treatments have become available, which not only lower blood glucose levels but can also reduce the risk of the complications of Type 2 diabetes. One such class of medications, sodium-glucose co-transporter-2 inhibitors (SGLT2is), work by preventing the kidneys from reabsorbing glucose back into the blood. This has been shown to lead to weight loss and further research has demonstrated additional benefits, such as a reduction in the risk of heart and kidney failure. Another class of diabetes drugs, called glucagon-like peptide 1 receptor agonists (GLP1RAs) have also demonstrated cardiovascular benefits in patients with Type 2 diabetes.

These effective treatments can be more expensive than other Type 2 diabetes medications. However, when used as recommended – especially in those at highest risk of complications – patients using these medications are less likely to develop complications, which can result in cost savings over time. While many clinicians are waiting for NICE guidelines to catch up with the wealth of recent evidence showing the benefits of these medicines, diabetes specialists can provide advice to ensure they are used where they are most likely to be effective, ultimately leading to improvements in patient quality of life and long-term cost-effectiveness for the health system.

Type 2 diabetes is a highly manageable and preventable condition. To reduce the burden of Type 2 diabetes in the UK, education and support for both healthcare professionals and people with the condition will be key. This, together with effective prevention and treatment strategies, will ensure that the number of people living with complications from Type 2 diabetes does not continue to increase at an alarming rate. ■

*Cello Health Communications through Napp Pharmaceuticals Limited has supported Professor John Wilding at the University of Liverpool to develop this article, in his role as Chair of the Improving Diabetes Steering Committee. This article has been solely put together by Prof John Wilding with medical writing support from Cello Health. Napp has had no involvement in the content of the publication other than to check it for factual accuracy.*

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# The Roche digital solution to the diabetes challenge

Diabetes is described as the epidemic of the 21st Century, in the view of Roche Diabetes Care, who are using digital technology and data management to help patients, healthcare professionals and payers address this costly challenge

There are more than 400 million people globally who live with diabetes<sup>1</sup>. In the UK alone, this figure is 4.5 million people<sup>2</sup>. The incidence of the disease, which is a characterised condition by high blood sugar levels, is growing – indeed, estimates suggest that some 629 million people worldwide will have diabetes by 2045<sup>1</sup>.

Much of this increase is driven by type 2 diabetes, but type 1 diabetes is still a concern with the number of cases increasing by 4% a year<sup>3</sup>. Regardless of the type, however, diabetes is a chronic condition, which is posing a costly concern for healthcare systems around the world. Meanwhile, people with diabetes are forced to juggle complex and fragmented data and make difficult medical and lifestyle decisions for themselves 24/7.

In many ways, diabetes has reached a tipping point. Just 6.5% of people with type 2 diabetes in Europe achieve their combined therapy targets<sup>4</sup>; the rest are struggling. In addition, physicians lack time and infrastructure support to sufficiently manage their patients and the disease. Together, this is putting pressure on healthcare systems and the costs are mounting<sup>1</sup>; in the UK, for instance, treating diabetes and associated complications represents 10% of the NHS budget, amounting to £10 billion each year<sup>5</sup>. The healthcare challenge presented by diabetes is immense – but it's not insurmount-

able. The challenge is making the system sustainable in the long-term.

The solution to this complex problem cannot solely be delivered by the introduction of another pharmaceutical drug. As Dr Partha Kar, diabetes and endocrinology consultant and associate national clinical director of diabetes with NHS England, said recently during techUK Rise of the Machines event: "It's not a new insulin alone that's going to change diabetes treatment – it's technology".

Roche Diabetes Care believes that digital health solutions and integrated diabetes management solutions have the power that will move the needle, bringing true relief to people with diabetes and developing a transparent system for healthcare professionals and payers that drives optimal care for this chronic condition.

Roche Diabetes Care envisions a holistic approach to addressing the diabetes challenge. Driven by technology and integrated solutions, this one open ecosystem, involving input from partners and other stakeholders, will ensure people with diabetes benefit from improved outcomes, physicians have the means to manage the disease and treatment, while payers can track the costs.

By better managing diabetes and designing more efficient healthcare

infrastructure and support systems, great strides can be made in avoiding the costly and life-altering complications associated with this disease. Roche Diabetes Care's approach aims to directly address the multifaceted and clinical complexity of diabetes currently seen across the healthcare system<sup>6</sup>.

The key to achieving improved outcomes is focusing on the data, with the patient at the centre. Diabetes is a complex condition where people with diabetes must monitor various and often times confusing, data sources including insulin and blood sugar levels, activity and nutrition. This complexity can be mastered by moving beyond drugs alone and taking a holistic approach where tools can integrate and analyse the data to help make treatment decisions, delay disease progression and empower people with diabetes to better manage their disease. This data can also be shared between the person with diabetes, their healthcare professional and their payer.

The Eversense® XL continuous glucose monitoring (CGM) system by Senseonics Inc is one example where Roche Diabetes Care, as the distributor in the UK and some European countries, is combining digital technology with data management in an open ecosystem to improve outcomes for people with diabetes. The Eversense XL CGM system by Senseonics is an implantable CGM

sensor, which can measure glucose values for up to 180 days, compared to seven or up to 14 days for non-implantable systems that are currently available in the market<sup>7</sup>.

The sensor is implanted underneath the skin on the upper arm and communicates with a rechargeable wearable smart transmitter, which alerts the person with diabetes when glucose levels become too high or too low. Meanwhile, real-time insights on glucose data and trends are relayed to The Eversense smartphone app. This CGM system provides people with diabetes more support in managing their blood glucose levels and therefore helps to better manage their condition. Furthermore, this data can easily be shared with the individual's physician for a more personalised approach to care.

In clinical trials, people with diabetes who used The Eversense CGM system for 180 days saw a reduction of 0.35% in their HbA1c, which identifies the average plasma glucose concentration<sup>7</sup>. The higher HbA1c, the greater the risk of developing diabetes-related complications, CGM has also been shown to support people in managing the extreme fluctuations of glucose which can cause both immediate harm and long term damage such as cardiovascular disease.

Systems such as The Eversense XL CGM system are digitising the data in such a way to make it more meaningful and transparent for people with diabetes and healthcare professionals. By managing the flow of this data, systems such as The Eversense CGM system are directly addressing the vast majority of the problems and challenges associated with diabetes. In addition, digitising data allows healthcare to move in the direction of personalised treatment, providing the right treatment for the right patient at the right time, which will also help to



*Interview with Françoise Le Poulichet, Roche Diabetes Care, International Business Leader, Insulin Delivery Systems*

overcome clinical inertia, improve outcomes and cut costs.

It's particularly notable that solutions such as continuous glucose monitors and digitally connected and integrated diabetes management solutions are what people with diabetes want. Healthcare systems around the world have already witnessed patients who, frustrated by the slow uptake of technology, have turned to reverse engineering and algorithms to create their own diabetes management solutions themselves.

In response to this do-it-yourself movement, the US-based JDRF has called for greater action on the part of industry and regulators to accelerate getting this technology to market and find ways to put in place the regulatory and legal frameworks for safe and approved technology to support the evolving research and development of artificial pancreas technology. Roche Diabetes Care is currently exploring different ways this collaboration with JDRF and other stakeholders could work. This is also an example that tackling the diabetes challenge requires a collaborative and innovative approach

that taps into the new technologies available.

Now is the time to elevate the debate, to involve all stakeholders, including people with diabetes, to work alongside the medical devices industry to address the challenges of this complex condition and to improve the outcomes for people with diabetes and healthcare systems alike.

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## Ending the stigmatisation of diabetes

Liam Sartorius, Founder at Rebelfit argues the case for ending the stigmatisation of diabetes, including the mental health aspect in this vein

**W**hen you ask people about diabetes the common misconception is that it's a disease brought on by the individual. A disease of lazy people, greedy people and people who are unable to discipline themselves to exercise or maintain healthy eating habits. This stigma attached to diabetes isn't just unkind, but the feelings of guilt, shame, blame, embarrassment and isolation have been linked to the poorer management of the disease. <sup>(1)</sup>

Whilst both weight bias and obesity stigma are gaining growing recognition as driving forces in the obesity epidemic <sup>(2)</sup>, to the point where World Obesity Day 2018 launched a campaign to "End The Stigma" <sup>(3)</sup>, there appears to be far less movement or campaigning around ending the stigmatisation of diabetes.

### Ending the stigma is key

Better education around diabetes not only has the potential to reduce rates of Type 2 diabetes, but also

protect the mental and physical wellbeing of those with the disease. The first thing we need to do is educate people on the difference between Type 1 and Type 2 diabetes. This is a huge source of distress to Type 1 diabetics in particular due to public misunderstanding of the different conditions. <sup>(4)</sup>

If diabetes was a road accident, then Type 1 diabetes would be an accident caused by a malfunction in your car, such as the brakes not working or the steering wheel locking, over which you have no control. Type 2 diabetes would be an accident where the driving environment caused the accident, such as heavy traffic or icy roads, rather than a malfunction in the car itself.

In both examples, the individual is not to blame.

Type 1 diabetes is not the individual's fault because it is an autoimmune disease affecting insulin production that often strikes with no warning. Type 2 diabetes is

not the individual's fault because it is a disease driven primarily by the "diabetogenic" environment we live in. A food environment where highly processed, highly palatable, highly addictive carbohydrates are cheap, readily available and even delivered to your door.

To put this in perspective, in the space of your body burning 20 calories of carbohydrate at rest, you could have ordered and have eaten 2000. And it is this change of food environment, from low carbohydrate/high physical activity to high carbohydrate/low physical activity that explains why rates of Type 2 diabetes are rocketing. Bodies and bloodstreams are being flooded with carbohydrate and sugar, without the physical exertion required to metabolise it.

New research suggests that people who live in cities with a high density of food outlets such as takeaways, restaurants and fast-food vendors have an 11% higher risk of developing Type 2 diabetes than those who live far from an instant meal <sup>(5)</sup>. Although 11% may seem small, it is significant enough to prove that it is our environment we should be blaming, rather than individuals.

The advice to "eat less, exercise more" has also contributed to this diabetogenic environment, by encouraging a whole generation to avoid high-fat foods in favour of processed carbohydrates and sugars, whilst putting that same generation off exercise by pushing recommendations that feel unachievable. We're all familiar with people starting diets and joining gyms in January, then throwing the towel in by February. This fall out rate could be instantly reduced by changing the advice to "eat a bit better, exercise a bit more", removing the pressure to maintain an unrealistic lifestyle.

## We need a three-pronged approach

Rather than blaming people with Type 2 diabetes for being "bad drivers"...

1. We should be putting speed limits on our motorways (environment focused);
2. We should be teaching people how to be better drivers (behaviour focused);
3. We should be encouraging people to slow down (mental health focused).

Putting speed limits on our motorways means legislating to change our food environment, such as limiting how many fast food outlets can be open in one area. Becoming a better driver means educating people about nutrition and fitness, and in particular how very small changes in your carbohydrate intake and exercise habits can dramatically reduce your risk of Type 2 diabetes. And encouraging people to slow down means teaching people to be more mindful, take more rest and be more present, rather than rushing around.

At the end of the day, Type 2 diabetes is a disease of speed. Primarily fast-food facilitating chronically elevated blood sugar. Approaching diabetes in the same way we approach driving safety has the potential to dramatically improve rates of Type 2 diabetes, in the same way speed limits, driving tests and the repeated advice to "slow down" has improved our roads. ■

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# Using technology-enabled mental health treatments for Type 2 diabetes

Sarah Bateup analyses how technology-enabled mental health treatments could be used to help those with Type 2 diabetes

A growing number of studies have indicated that patients with diabetes are more likely to experience common mental health problems such as anxiety or depression. Grigsby et al., (2002) reported that patients with diabetes are three times more likely to be depressed than the general population. They also suggested that 40% of patients with diabetes had a diagnosable anxiety disorder. In addition, people with diabetes can also experience disease-specific psychological issues such as denial of the diagnosis, avoidance of treatment-seeking behaviours, fear relating to hypoglycaemia or future complications, eating disorders and adjustment disorder. It is recognised that patients with diabetes respond well to evidenced psychological therapies like cognitive behavioural therapy (CBT).

Ieso Digital Health delivers CBT, via online written communication, to NHS patients across the UK. The online Ieso Method has demonstrated equivalence to traditional face-to-face CBT and has become an accepted convenient and effective way to receive psychological therapy.

Ieso Digital Health, in collaboration with Roche Diabetes Care, is running a research trial to test the assumption that CBT delivered online by qualified therapists using the Ieso Method is equally as effective as face-to-face CBT at:



1. Reducing the symptoms of anxiety and depression;
2. Enabling people to manage their diabetes more effectively;
3. Reducing the distress that can sometimes be associated with having a diagnosis of diabetes.

## Who can participate?

Anyone over the age of 18 who has had a diagnosis of Type 2 diabetes for at least 12 months and feels that they may be anxious or depressed can participate. Participants must have access to an internet-enabled device such as a tablet, laptop, desktop computer or smartphone. Participants must feel confident in their ability to read and write in English, although spelling and grammar are unimportant.

## What

CBT will be delivered by British Association of Behavioural and Cognitive Psychotherapy (BABCP) accredited CBT therapists. The therapists will provide treatment online using synchronous written communication (typed). For further information relating to this method please see [www.iesohealth.com](http://www.iesohealth.com) . The therapy provided will be identical to traditional face-to-face CBT in that it will use evidenced-based disorder-specific treatment protocols with fidelity to the CBT model.

## Where

CBT will be delivered online using the web-based platform provided by Ieso Digital Health. This means that the participants can be located in place of their choosing whilst receiving



therapy. Participants may also choose the day and time of day that they have their therapy appointments.

**"Ieso Digital Health delivers CBT, via online written communication, to NHS patients across the UK. The online Ieso Method has demonstrated equivalence to traditional face-to-face CBT and has become an accepted convenient and effective way to receive psychological therapy."**

## When and how much

Participants will receive a disorder-specific treatment protocol for patients with an anxiety disorder or depression and a diagnosis of Type 2 diabetes. Participants will receive all elements of the treatment although this may be moderated to meet their individual needs. For example, some patients may find working behaviourally more helpful than working with cognitions. These types of moderations are very normal when delivering CBT. Treatment will consist of weekly therapy appointments lasting 60 minutes. Participants will also be encouraged to participate in between session practice tasks. Between session practice tasks are a routine part of CBT. Average treatment durations are seven treatment sessions over a period of two months, although patients who require more sessions (in order to gain benefit) will be provided with more sessions.

## Treatment adherence

The therapists' ability to deliver the interventions with fidelity to the CBT model and adherence to an evidence-based protocol will be assessed by a team of clinical supervisors at Ieso Digital Health. This is assessment is possible because the intervention is delivered online using synchronous written communication and therefore each therapy appointment is recorded as a transcript. It is, therefore, possi-

ble to quality check the intervention provided to every participant. Fidelity to the treatment model will be assessed using the standardised and validated tool 'Cognitive Therapy Scale-Revised' (CTS-R). The CTS-R is routinely used in research settings to ensure that the intervention provided is CBT and not another type of therapy. The CTS-R is also routinely used in higher education settings as a formative and summative assessment of trainees' ability to deliver CBT. The CTS-R is a 12-item scale where each item is scored on 0-6 Likert scale where 0 is incompetent and 6 equates to expert skill. The final score is reported as a total percentage. A score of 40% is considered to be competent.

## Outcome measures

The primary outcome measures used at every session are; the Patient Health Questionnaire (PHQ-9). The PHQ-9 is a 9 item, self-administered questionnaire that measures the severity of depression and the Generalised Anxiety Disorder Questionnaire (GAD-7), the GAD-7 is a 7-item self-administered questionnaire that measures the severity of generalised anxiety disorder.

The secondary outcome measures are the Patient Activation Measure (PAM) and the Diabetes Distress Scale (DDS).

The diabetes distress scale (DDS) is a 17-item scale that captures four critical dimensions of distress: emotional burden, regimen distress, interpersonal distress and physical distress. First published in 2005, it has been used widely around the world as a clinical instrument for an opening conversation with one's patients as well as a critical outcome measure in numerous studies. (See [www.diabetesdistress.org](http://www.diabetesdistress.org)).

The PAM is a tool that helps health care professionals assess a patient's activation level and their level of knowledge, skill and confidence in managing their long-term health condition. Evidence has demonstrated that when patients are supported to become more activated they are better able to manage their long-term condition and they have better physical health. For further information [click here](#).

## Conclusion

This is the first study that investigates the efficacy of online, therapist-delivered CBT specifically for patients with diabetes and a co-morbid mental health condition. The research is timely and necessary now particularly if we are to begin to tackle the dual problem of lack of availability of CBT and an increase in the prevalence of diabetes and mental health disorders.

## Get in touch

If you would like more information about this study, or you know someone who would like to take part please contact Sarah Bateup, Chief Clinical Officer at Ieso Digital Health at [s.bateup@iesohealth.com](mailto:s.bateup@iesohealth.com).



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# Mental capital and wellbeing at work

Professor Sir Cary Cooper, 50th Anniversary Professor of Organizational Psychology & Health at the University of Manchester, provides a fascinating overview of mental capital and wellbeing at work from the UK and European angle

**M**ental wellbeing at work is now top of the HR agenda in many private and public organisations, with the Office of National Statistics highlighting that stress, anxiety and depression is costing the UK economy 15.2 million sick days, with presenteeism (workers turning up to work ill or job dissatisfied but contributing little-added value in terms of their performance) estimated as twice as costly as absenteeism.

The OECD calculated that mental ill health costs the UK economy £70 billion per year, equivalent to 4.5% of GDP. These health and economic costs, together with the UK seventh in the G7 and 17th in the G20 countries in productivity per capita, make a clear human and financial case for businesses doing something about mental wellbeing. This is not just a problem in the UK, but in most developed countries, although the sources of a lack of wellbeing may be different.

Research in the UK, in the EU and most of the developed world, has suggested a number of causes of lack of mental wellbeing in the workplace. Firstly, the evidence points to the role and competencies of the line manager, from shop-floor to top-floor. In many developed countries, we have technically competent line managers, but many do not have the social and interpersonal skills necessary for managing people where jobs are intrinsically less secure, where workloads are unmanageable, deadlines unrealistic and longer hours are required to clear people's in-tray. We need to select line managers in the future, of course on their technical skills, but equally, on their social skills – there needs to be parity between these two competencies.

Secondly, communication and information technologies are increasingly responsible for intruding into people's social and family time. Emails usage, through smartphone technology, is now creating a 7-24 culture,



“We need better guidelines from employers to their managers about what is unacceptable in accessing people during their non-work time; and how emails are contained within the workplace itself (e.g. not sending emails to people in the same office, not cc-ing people not directly involved in the work).”



where people are accessing their emails at night, at weekends and when they are on holiday. A recent French law, which forbids managers from sending emails to their staff out of office hours is a statutory response to this trend. Yet, many employees and employers want more flexible working, which constraints like this, inhibit. We need better guidelines from employers to their managers about what is unacceptable in accessing people during their non-work time; and how emails are contained within the workplace itself (e.g. not sending emails to people in the same office, not cc-ing people not directly involved in the work).

Finally, we need managers to give more control and autonomy to their staff, micro-managing people at work leads to people feeling that they aren't valued or trusted to do a good job. As part of this, employers need to control working hours, the evidence is mounting that 'consistently' working beyond a 40-hour week can have a damaging impact on their health, their family and their productivity – and in many countries the working week extends well beyond a 40-hour working week in an office environment, and if you add on people working in the evenings and at weekends, the time for rest and recuperation is being seriously squeezed.

The study in Gothenburg in Sweden demonstrated that a 30-hour working week outperformed a 40-hour

week in terms of job satisfaction and productivity. The 19th century social reformer, John Ruskin, summed up how important the quality of working life should be in 1851 at the beginning of the Industrial Revolution: “In order that people may be happy in their work, these three things are needed: they must be fit for it, they must not do too much of it, and they must have a sense of success in it.” ■

*Professor Sir Cary Cooper, CBE, is the 50th Anniversary Professor of Organizational Psychology and Health, ALLIANCE Manchester Business School, University of Manchester, UK; and President of the Chartered Institute of Personnel & Development; and co-author of Wellbeing: Productivity and Happiness at Work (Palgrave Macmillan, London, 2018).*

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# Leading Well: Is the way you are working, working?

Alex Elmywood, Commercial Director, Organisational Improvement discusses how the workplace can be improved to help better employee mental health and wellbeing

**W**e all know the impact a happy and healthy workforce has on performance. Our wellbeing influences the way we see our world, interact with others and undertake our responsibilities. Yet in reality – the pressure that many of us are facing at work is far from what we would consider conducive to a happy and healthy workplace. Technology, resource issues, stakeholder demands, customer demands; the list is endless and it all affects our wellbeing.

Occasionally we are inspired by individuals who have been able to create a life of balance and purpose. Many of us look on in envy as we struggle to see past our day to day responsibilities and how such a life could be possible. We block out the possibilities and continue to juggle our proverbial balls, hoping that the few we occasionally drop don't cause too much of a ripple. And worse still – we learn to accept and tolerate the things in our world that cause poor wellbeing such as our energy levels or our mood.

And whilst we advocate individuals taking ownership of their own self-care, organisations do play a part in supporting and guiding wellness.

Over the last 15 years, Organisational Improvement has been helping companies with the concept of healthy workplaces. Not a day goes by when we don't see a fabulous example of



great practice. Nowadays, many organisations have wellbeing programmes and advancements in thinking have seen a rise in both the psychological and physiological aspects.

So why do we continue to see absenteeism linked to mental health increasing? In a 2018 report by the CIPD, it claims that 71% of long-term sickness within the Public Sector is stress related and the number of sick days per employee is higher than any other sector in the UK; at 8.5 days per employee (CIPD Health and Wellbeing at Work Survey 2018).

As mentioned, we are starting to observe organisations putting in a lot of effort to support wellness, however, the intention often fails to change the culture or beliefs and as such has limited impact in changing

behaviours in the long-term. Our work with organisations has identified the incredible impact that leaders can have on the organisation's ability to adapt and embed wellbeing principles – both positively and negatively and it is them that will help achieve such a strategy succeed or fail.

There are two questions which organisations should consider when it comes to wellbeing: how confident and capable are leaders at supporting and guiding people effectively? And through their own values and behaviours, are leaders seen as an advocate of health and happiness?

## **Confidence and capability:**

Many organisations within the public sector place a lot of emphasis on leaders managing absence yet less than 50% of public sector organisations train managers in mental health

awareness (CIPD Health and Wellbeing at Work Survey 2018).

Developing capability is not about increasing the number of practitioners. It's about developing their knowledge and skills to get the best out of our people. We recognise that training plays a part – particularly in recognising the symptoms of ill-health. But it goes much deeper than this. Leaders need to have a genuine interest in the people around them and buy-in to the value of workplace wellbeing.

The Leading Well programme uses a five-step guide:

### **Understanding the whole person:**

How well do your leaders know the people around them? Gone are the days where we leave our troubles at home. We recognise wellbeing issues can be linked to personal circumstances and this affects the way that we behave, interact and engage with others. Encouraging leaders to develop their knowledge of the whole person will enable them to provide support in a much more holistic way – and in turn, have a greater opportunity to maximise an individual's performance at work.

### **Recognising the signs:**

Lack of confidence stems from three things:

- Lack of knowledge of an extremely complex area;
- Fear of saying and doing something wrong – and making matters worse;
- Lack of proactivity resulting in issues escalating.

Knowledge will enable leaders to be much more proactive in the way they support people – making it much more manageable and less intrusive.

### **Tackling the stigma of mental health:**

There is no doubt that it is starting to be tackled – however, there is still a long way to go. It is the role of the leader to stand up and challenge the negative views that sharing mental health concerns is considered anything other than positive. Sharing our own vulnerabilities is a step towards tackling the issue.

### **Building trust, honesty and openness:**

None of the above can happen without the foundations of positive and constructive relationships. Developing self-awareness of how actions and behaviours instil trust or indeed distrust.

### **Keep it simple:**

This is not about creating an overcomplicated process. This is about having a chat – having a genuine interest in the person in front of you – without judgement or prejudice. Being able to listen and offer the support that's needed – whether that's an ear or indeed signposting them to professional help.

### **Role models**

We recognise the important role of leaders to create mentally healthy workplaces, but who is looking after them? The ones that are looked upon to be role models are often the ones with the poorest wellbeing. How can an organisation be truly happy and healthy, if its leaders are not? Only when one is in control of one's own psychological and emotional wellbeing can you start to support the wellbeing of others. It's like the gas mask on the plane – you need to put your own on first to ensure you are safe before you can support others.

Many factors contribute to a person's

likelihood of developing a mental health condition but the high demands of a leadership role, the squeeze on time for self-care, poor quality sleep and diet and the fact that it can be lonely at the top, all combine to increase the risk.

This is an area which is lacking in many wellbeing programmes. Offering leaders the time and energy to look at their own physiological and psychological wellbeing and helping them make the steps changes necessary in creating a happier and healthier workforce that's driven from the top.

Our Leading Well programme, delivered in conjunction with Manchester Stress Institute is designed to meet these increasing needs of leadership teams in driving a cultural change to ensure workplace wellbeing is truly embraced.

NW Ambulance Service worked with Manchester Stress Institute to deliver a positive impact – read the case study [here](#).

Visit our website for more details on how to start Leading Well: [www.leading-well.uk](http://www.leading-well.uk)

## Leading Well<sup>®</sup>

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# The Werther effect – About the handling of suicide in the media

Vivien Kogler and Alexander Noyon from Mannheim University of Applied Sciences investigate suicidality, the Werther effect and the role of medial presentation in this context. As guest authors at Pfalzkrankenhaus they summarized the subject of the thesis written by Vivien Kogler

**T**he Werther effect is the mimicry of suicide after a highly publicized suicide.

More than 10,000 people in Germany take their own life every year – in the age group of those up to 34 years, suicidality is the most common cause of death following accidents. At a time when every aspect of social life is considerably influenced by media, the question arises as to the effects of media coverage on suicide quotas.

As a positive effect, the media offer cheap and fast help for those concerned<sup>1</sup>. Here especially internet forums and chats can function as a room of exchange<sup>2</sup>. However, again and again these fall into disregard due to so-called suicide pacts<sup>3</sup> in which people make agreements to commit suicide. Moreover, the internet carries further risks. Within a very short time information on suicide methods, their advantages and disadvantages as well as sources of supply for weapons or drugs can be spread via dubious websites<sup>4</sup>.

## What is the Werther effect

A special risk associated to media is the “Werther effect”. Dating back to the high number of suicides after the publication of Goethe’s “The Sorrows of Young Werther” in 1774, it describes the apparition of copycat suicides after media reports on suicides. Scientifically it was first described in 1974 by



David Philipps whose study, until today, has been considered to be a pioneer work and constitutes a starting point for a large number of further studies. In this context the way of media reporting has proved to be highly relevant. For this reason, the WHO published guidelines in 2001 determining exactly what to avoid when reporting about a suicide in the media. This includes precise details on the suicide method, personal information on the person having committed suicide or some expressions such as “self-inflicted death”<sup>5</sup>.

Instead, if a report focuses on resource-oriented aspects, this may possibly even lead to a reduction of the suicide rate<sup>6</sup>. This is then called the “Papageno effect”, which was first

empirically confirmed in 2010 by an Austrian work group headed by Thomas Niederkrotenthaler. The results of this study unmistakably indicate that the prevention of suicidal behaviour by the media is possible, for example by presenting a successful coping with crises<sup>7</sup>. Other factors having suicide-preventing effects include the mentioning of professional help services or the publication of warning signals and backgrounds listed in the WHO guidelines<sup>5</sup>.

Prevention, however, can also take place at another level. Expert interviews carried out by the authors revealed that the still existing treatment of suicidality as a taboo represents a huge problem. As a result, the bereaved not only experience the loss



of a loved one but also do not receive help or understanding from the environment. Consequently, further (copy-cat) suicides may occur – without any medial impact. Therefore, it must be a matter of importance to counteract this tabooing since suicidality is part of our society and should neither be ignored nor stigmatized. Only if it is discussed openly, possibilities for prevention can be detected and developed further.

## Public healthcare

Effective acting in this area can be illustrated for instance when looking at the task of school social workers. As children and adolescents often use dubious websites unthoughtfully, it is important to give them an understanding of how to handle media competently, particularly those based on internet. In doing so, specific topics such as the handling of suicidality in the media can be addressed. This field is extremely valuable for the prevention of suicide because, thus, tabooing can be counteracted as early as possible. If a pupil committed suicide, it is essential to talk about it in class and to inform the classmates to avoid a glorification of the victim as well as follow-up suicides<sup>8</sup>.

The expert interviews also revealed the necessity to change the public healthcare communication. Media reports should increasingly focus on the aspect of recovery and the positive facets, for example by means of interviews with persons having overcome a crisis, instead of concentrating on sickness and its negative consequences. A comparison drawn by Niederkrotenthaler et al. (2017) makes this clear: When media report on psychosocial problems or diseases, for instance on cancer, the report does not exclusively refer to mortality rates. Special emphasis is placed on

treatment possibilities or successfully coped diseases. Relating to suicidality, the focus should therefore be on the way out of the crisis or on reports on intervention successes<sup>9</sup>. This would increase the already mentioned Papageno effect and reduce the Werther effect.

Basically, it can be said that the effects of the media – also on suicidality – have meanwhile been investigated well. Primarily, however, this holds true for the traditional media such as press and television. Here, guidelines for the reporting on suicides have already been established. The extension of these WHO guidelines in the past year reveals, however, that these media continue to be the subject of research to minimize the Werther effect.

Regarding the internet relatively little is known about the way suicidal contents work. Like every medium the internet, too, holds both chances and risks. Some of these opportunities, for instance the possibility that preventive help offers can reach a huge number of users within a very short term of time, are already known. Particularly the preventive potential of social media is still not used sufficiently at present. The experts interviewed find it difficult to ensure a constant supervision in the internet which is necessary to be able to guarantee a preventive benefit. Further research is needed to adjust the recommendations addressed to online media on the issue of media coverage. This must remain a continuous process.

Furthermore, a change in the public healthcare communication should be encouraged. To advance prevention it is important to counteract tabooing and to precisely consider the needs of the bereaved. It is also required to

observe the environment of a suicide and provide appropriate offers to reduce the danger of follow-up suicides.

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# Critical care nursing: Reshaping professional talent roadmap over the coming years

Cecilia Van Cauwenberghe from Frost & Sullivan's TechVision Group turns the spotlight on to the key issues around critical care nursing, with a focus on reshaping the professional talent roadmap over the coming years plus clinical competence

**D**uring the past five years, nursing programmes focussed on critical care began to encourage the admittance of a greater number of students in order to provide a more innovative education system-based on higher care quality and safer clinical practice. In fact, clinical and professional competence in intensive nursing play a significant role as a specific knowledge base, skill base, attitude and value base that build its foundations over the professional experience in intensive and critical care nursing (Ääri et al., 2018). Broadly speaking, the nursing competence involves adherence to clinical guidelines and nursing interventions standards, absolute ethical behaviour, smart decision making, development work, and multi-disciplinary collaboration.

Encompassing this vision of critical care nursing, a number of clinical teaching models based on standardised and customised simulation labs were performed to improve intra-professional collaboration among complex clinical centres and healthcare professionals and junior/senior-level nursing students (Boothby et al., 2018).

## **Future skills and talent nursery roadmap**

Leading healthcare companies are presently redesigning its talent attraction policies in order to improve the effectiveness of their graduate and undergraduate programmes (Das, 2015). Therefore, a certain level of diversity around their recruitment process, based on student profiles and universities prestige is crucial to attracting high potential candidates. To achieve this goal, twin track approaches to career development, that is, professional and management approaches, focus on an in-depth understanding of success profiles

resulting from competency models that should be in place in the future for both potential career pathways and the development of future managers.

## **The road ahead in Europe**

### **Regional commitment and collaboration work**

These strategies are also stimulated by the European Federation of Critical Care Nursing Associations (EfCCNa), a formal network of nursing associations in Europe focussed on promoting collaboration and equity among the national critical care member associations. According to EfCCNa, collaboration is crucial to advance critical care practice, education, management and research in Europe. Indeed, the Belfast Declaration, established in recognition of the First Global Critical Care Nursing Organizations Joint Meeting reflect the commitment of most relevant European nursing associations to promote and support optimal nursing practices worldwide.

Among the most important goals defined by the organisations, the identification of novel opportunities to collaborate in further advancing nursing education, practice, and research, advocating for the highest standards of critical care nursing practice worldwide, are of note. The commitment is extended to the advancement of the state of critical care nursing based on the constitution of multi-professional team-based practices to promote in-depth knowledge, as well as, the engagement of patient and family-centred care to support ongoing care and recovery beyond clinical institutions (Butcher et al., 2018).

## **Big themes for discussion**

Among the most relevant issues to be covered in order





# Dementia and Alzheimer's disease: The priorities for medical research

Dr Carol Routledge, Director of Research at Alzheimer's Research UK charts the priorities for medical research when it comes to dementia and Alzheimer's disease

**T**oday, as you're reading this, 850,000 people in the UK are living with dementia. Recently it has overtaken heart disease as the UK's leading cause of death. With no treatment capable of stopping or slowing the underlying diseases, it's a condition that no-one has yet survived.

Dementia is a devastating condition, caused by physical diseases, most commonly Alzheimer's disease. Yet we know that research has helped millions of people survive diseases like cancer and HIV/AIDS, and we can make the same progress for dementia too. Through medical research, we will bring about a lasting solution to dementia, but we must intensify our efforts to make life-changing breakthroughs possible.

At Alzheimer's Research UK, we're focusing our energies on four key areas of action to make our vision of a world where people are free from the fear, harm and heartbreak of dementia, possible. We're working to understand the underlying causes of dementia, to detect and diagnose these diseases earlier and more accurately, to help people reduce their risk and ultimately to develop medicines that keep people connected to their families, their worlds and themselves for longer.

We are building on 100 years of scientific discoveries to translate breakthroughs in the laboratories into life-changing treatments. Through strategic initiatives like our [Drug Discovery Alliance](#) and the Dementia Consortium, we are bridging the gap between academic research and pharmaceutical companies in order to accelerate this work. These initiatives are providing the funding, resources and expertise to increase the number of new drug targets emerging from research, and capitalising on breakthroughs that hold the promise of transforming lives.



*Dr Carol Routledge, Director of Research*

Advances in technology are providing huge opportunity to improve how we detect the diseases that cause dementia, ensuring an accurate diagnosis for everyone at a time that's right for them. Detecting the diseases that cause dementia early is important, especially as research is now showing that diseases like Alzheimer's can begin up to 15 -20 years before any symptoms start to show. We believe this could offer a vital window of opportunity to intervene before widespread damage to the brain has taken place, but this would mean transforming the way these diseases are detected and diagnosed.

The ability to detect and subsequently diagnose these diseases before symptoms begin is a crucial goal for research and requires technology that has yet to be harnessed. Recent advances in innovative technologies and big data offer a critical opportunity for tackling this challenge. By using the power of these tools appropriately and effectively, we could potentially revolutionise



our ability to detect, diagnose, and ultimately treat, diseases like Alzheimer's much earlier. This will require a major effort and significant investment, but we believe this approach could lead to huge benefits for people affected by dementia and their families.

If we can diagnose earlier than we currently do, we could not only treat people at an earlier stage, but we could empower more people to make lifestyle choices that could benefit their brain health. This work will be vital over the coming months and years.

All of this work is central to our mission to bring about a life-changing treatment for dementia by 2025 – a mission that mirrors the global ambition set by world health leaders at the G8 Dementia Summit in 2013. If we're to reach that ambition and offer an effective treatment for millions of people living with dementia around the world, we can't afford to wait.

We are making good progress in dementia research, but we must not become complacent. That's why Alzheimer's Research UK has pledged to commit a landmark £250 million to dementia research by 2025, and we are calling on the public to stand with us to make this ambition possible. Yet this alone is not enough. Governments around the world also have a crucial role to play.

Currently, UK government spending on dementia research is equivalent to 0.3% of the condition's annual cost to the UK economy, a cost that now stands at £26 billion a year. We're calling on the government to increase that to 1%. Just 1% will bring more researchers into the field. Just 1% will help us find new ways to detect and diagnose dementia and widen the search for new treatments.

The scale and complexity of dementia mean that we must have a long-term plan to tackle this enormous challenge – the necessary investment, support and incentives must go beyond the parliamentary cycle. We must push onwards and keep up the momentum if we are to deliver new treatments.

By driving progress across all these important strands of work, we will make life-changing breakthroughs possible. ■

**Dr Carol Routledge**  
**Director of Research**

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# The importance of an ageing demographic

Graham Armitage MBE puts the ageing demographic in the spotlight to highlight their importance to society, in this analysis

**D**emographic ageing is a huge triumph for mankind, which has delivered great benefits economically and socially, but it is also a powerful driver for change. It is changing the shape of our society, and if we are to continue to benefit and address some of the accompanying challenges, we must respond with real innovation, to create a world which is efficient, effective and good to live in at all stages of life, despite a very different age profile from previously.

Recognising this, in late 2014, the UK Government announced the intention to establish a National Innovation Centre to respond to the global challenge of ageing. In 2015, funded half through the Medical Research Council and half by Newcastle University, the £40 million National Innovation Centre for Ageing was established in Newcastle upon Tyne. The Centre is rooted in the 25-year record of ageing research in Newcastle now co-ordinated by [Newcastle University Institute for Ageing](#), but it brings together experts and knowledge from globally leading science, nationally and internationally.

Older people are a large under-served proportion of consumers whose needs and wishes are a major area for potential economic growth. With good health and the right support, they are a social asset, whether working for longer, volunteering, taking on caring roles or merely as consumers. They also have a great deal of knowledge and under-

standing of ageing from their own experience and that of friends and loved ones. Yet, this is not a group which has been highly visible in innovation. The National Innovation Centre for Ageing hosts VOICE, a unique organisation comprising citizens who contribute experience, ideas, insights and vision to research and innovation, to provide that opportunity.

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**“Our unique access to expertise drawn from a wide range of academic disciplines, business and industry, and ageing adults means that we are aware of market trends, health and social care challenges, and the latest innovations in the industry.”**

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VOICE volunteers work with universities and external organisations to:

- Improve the focus, quality, relevance and impact of research
- Stimulate and shape social and technological innovation
- Enjoy lifelong learning and become research and innovation active citizens
- Make a positive difference to the lives of older people across the globe

The involvement of VOICE members in research helps to focus academic knowledge, creativity and expertise on finding solutions and innovations that will make a difference to and have an impact on people's lives.

The National Innovation Centre for Ageing works with government and corporate organisations, SMEs and innovators and with other centres of innovation, to ensure that new products and services are driven by evidence and by the needs and aspirations of the public.

Our areas of focus include:

- Living better for longer – helping us all stay as healthy, well and engaged as possible as we age.
- Age-friendly places – adapting our built and social environments and creating homes and communities where we can live and work for longer, so that we can maximise the quality of our later years.
- Inclusive design – ensuring that products and services meet our needs and aspirations, whatever our age or ability.

From 2020, we will be based at our iconic new building at the heart of Newcastle's city centre Helix research and innovation area. Funded by Newcastle University, the Medical Research Council, and the Department for Business, Energy and Industrial Strategy (BEIS), the building will also house the National Innovation Centre for Data and the National Institute for Health Research Innovation Observatory, together with key research and innovation projects and businesses.





This will bring together world-leading scientists, business and industry, health and care providers, and the public in a unique space that is designed to lead on innovations that improve all aspects of life for our ageing societies.

Our unique access to expertise drawn from a wide range of academic disciplines, business and industry, and ageing adults means that we are aware of market trends, health and social care challenges, and the latest innovations in the industry. Our focus on horizon scanning ensures that we are always one step ahead. Our international linkages and projects will ensure that the innovations we support can be globally relevant supporting ageing throughout the world.

The National Centre provides a variety of mechanisms for engagement with ageing in support of innovation, including training, consultancy and is able to organise and support collaborative and commercial research, working with its academic partners. We are keen to work with a wide variety of partners to assist them to design, develop, and deliver at scale new products and services which will:

- lead change in the way that we experience ageing,
- Create economic growth,
- Extend healthy life expectancy.

If you would like to work with the National Centre, in developing your

own responses to ageing we welcome approaches via [ageinnovation@newcastle.ac.uk](mailto:ageinnovation@newcastle.ac.uk) and would be happy to explore how we could help you with your projects.



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# Turning up the volume of the patient voice in dementia research

Dr James Pickett, Head of Research at Alzheimer's Society presents the case for turning up the volume of the patient voice when it comes to dementia research in the UK today

**T**here are 850,000 people living with dementia in the UK alone and this number is set to rise to one million by 2021. Of the top ten causes of death, dementia is the only one we can't cure, prevent or even slow down. It is only through research that we can fully understand what causes dementia, develop effective treatments, improve care and one day find a cure. But for research to truly progress, we need to hear from more people affected.

Over the past twenty years, increasing value has been placed on the lived experience of patients and the public in research. More and more research now includes patient and public involvement (PPI). While many agree that morally and ethically people with lived

experience of a condition should be involved in research, there are still challenges to supporting involvement and best practice guidelines are not yet agreed.

## Changing research

Today, Alzheimer's Society is working tirelessly to challenge perceptions around dementia. We have pioneered the active involvement of people affected by dementia through our [Research Network](#) since 1999. Our volunteers have been vital in some of the biggest research achievements, including campaigning for NICE to widen access to treatments, reducing antipsychotic use, and lobbying for more research into improving care. People with lived experience are at the forefront of our research.





## NEURODEGENERATIVE DISEASE

it must be tailored to the needs of the project, the researcher and the volunteer. We need to give researchers and people affected by dementia the tools work together to beat dementia.

PPI is integral to every single research project we fund at Alzheimer's Society, which encompasses biomedical research, research into dementia care and health services. All of our Research Network volunteers have a unique experience they bring to the research, and we support volunteers with additional training on the basics of dementia science and research methods to help them to feel comfortable in conversations with researchers. For our researchers, we offer support with input from people with lived experience of dementia at any stage of their research, even research we aren't funding directly. Our philosophy is that people with dementia and carers are able to contribute a unique insight into every stage of the research process.

PPI in research continues to evolve and improve to better meet the needs of research. Alzheimer's Society will continue to embed PPI in dementia research work with researchers to maximise its potential and involve as many people as we can in dementia research.

It is only through research that we can understand what causes dementia, develop effective treatments, improve care and one day find a cure. But for research to progress, we need more people to take part.

Alzheimer's Society is a partner in [Join Dementia Research](#), a nationwide service that allows people to register their interest in participating in dementia research and be matched to suitable studies. Whether you want to take part in research or get more involved in the research process, we need everyone to unite and help research to beat dementia. ■

### **Dr James Pickett** **Head of Research**

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We have seen through our own experience, and the experience of other researchers, the impact of involving people affected by dementia. We published our own [report](#) of the unique contribution and benefits of PPI. We also co-edited an edition of '[Dementia: the International Journal of Social Research and Practice](#)' that shares just a few of the many different ways the voice of people with dementia supports research. The journal includes 11 articles co-authored by researchers and people affected by dementia, many of whom are our own Research Network volunteers.

We are moving the conversation about PPI forward from 'proving' why it should be done to 'improving' how we can do it. Although PPI is clearly valuable, it is by no means perfect and can present challenges for researchers, volunteers and funders.

### **Paving the way**

We want anyone with experience of dementia to feel empowered to play their part in research. We want researchers to understand how to get the best out of working with people affected by dementia for their research. More than just avoiding tokenistic involvement, we want to help maximise the impact of PPI. We understand that PPI is not a one size fits all approach,



# Early diagnosis of neurodegenerative disorders: Where are we now?

Dr Gerry Morrow shares his thoughts on the current state of play when it comes to the early diagnosis of neurodegenerative disorders, and asks the questions, can we screen, and should we screen?

The World Health Organisation has estimated that 47.5 million people worldwide have dementia and there are 7.7 million new cases each year. In the UK in 2014, there were an estimated 835,000 people living with dementia. By 2051, this number is expected to increase to over 2 million. About 29–76% of people with dementia or probable dementia in primary care are estimated to be undiagnosed.

Parkinson's disease is another common neurodegenerative condition in elderly people. There are about 137,000 people living with Parkinson's disease in the UK. The prevalence of Parkinson's disease increases with age – the prevalence is 4–5 per 100,000 people in people aged 30–39 years, compared with 1,696 per 100,000 people aged 80–84 years.

The disease burden for patients, carers, relatives and the wider health economy is enormous and increasing. This in tandem, with the fact that these conditions are life-limiting has resulted in a clinical imperative to provide an earlier diagnosis to provide improved disease-modifying therapeutic options.

It is thought that many neurodegenerative disorders may share a common pathophysiological aetiology through a problem with abnormal protein transport synthesis and deposition, mitochondrial dysfunction, and defects in intracellular trafficking, causing subsequent plaque formation and neurofibrillary entanglement. This then presents both a problem for delineating a definitive sub-type disorder diagnosis but also a potential window for early diagnosis and interventional therapeutic hope for the future.

## The challenge of making a diagnosis of dementia?

It can be extremely difficult to make a definitive clinical

diagnosis of dementia. The reasons for this are that it presents variably in different individuals and usually has an insidious onset with non-specific signs and symptoms. In practice, diagnosis is mainly based on an expert clinical assessment and on neuroimaging. Neuroimaging may assist in excluding some cerebral pathologies but may not be conclusive. The uncertainty around the time of a possible diagnosis is often the most challenging for patients and their relatives. The fear of inexorable cognitive decline and reduced life expectancy with no prospect of curative therapeutic solutions is often viewed as being as problematic as the disease process itself.

## What can we then do to provide an early accurate diagnosis?

Newer diagnostic tools have been discussed and employed in research settings for some years to assist with the diagnosis of neurodegenerative disorders. These include the use of biomarkers in blood and cerebrospinal fluid (CSF), genomic sequencing, and bioinformatic data. There is potential for each of these approaches or a combination. There are however problems with each.

Blood biomarkers would seem the simplest and cheapest option. Despite the initial optimism of their potential this has failed to provide reliable, sensitive or accurate diagnostic information for clinicians.

CSF biomarkers for amyloid beta 42 and tau certainly are more accurate, but sampling CSF is an invasive procedure with the potential for adverse effects.

Genomic sequencing may prove useful in the future, but this is an expensive technique with significant limitations which include the accuracy of defining benign from pathological genetic variation. For example, some



Dr Gerry Morrow

researchers estimate that in a single individual genome up to 11,000 non-synonymous genetic variants exist.

Bioinformatics has raised hopes once more of an early diagnosis. Specifically, analysing computer keystrokes and digital phenotypes of people using internet search engines. This work provided a large database proving possible early diagnostic predictors of cognitive decline and functional debility, such as velocity and jerkiness of mouse movements.

## Should we screen for neurodegenerative disorders?

Any potential screening approach should be informed by Wilson's criteria. These include the concepts that:

- There should be a test that is easy to perform and interpret, acceptable, accurate, reliable, sensitive and specific;
- There should be an accepted treatment recognised for the disease;
- Treatment should be more effective if started early.

Clearly, we are not at this stage for dementia, Parkinson's disease or other neurodegenerative disorders. The tests currently at our disposal are expensive, invasive, rely on non-validated databases and are not sensitive or specific enough for reliable point of care testing.

## What can we expect in the future?

Future diagnostic tools will need to provide more reliable benefits for patients and clinicians. We hope that we may be able to differentiate benign from pathological variants both from a genetic and bioinformatic perspective. We also hope that simpler blood testing will find its way into the primary care environment to allow for more rapid diagnosis and that this test will lay the groundwork for a potential therapeutic intervention. ■

## Further information

A leading healthcare professional, Dr Gerry Morrow has over twenty years' experience working as a GP and a proven track record of advising and working with NICE, Royal Colleges, Academic Health Science Networks and senior NHS bodies. As the Medical Director of Clarity Informatics, one of Gerry's responsibilities is the production and Clarity's clinical guidance – Prodigy – which forms the clinical content of NICE's Clinical Knowledge Summaries (CKS) service and is designed to assist clinicians to treat common conditions and symptoms.

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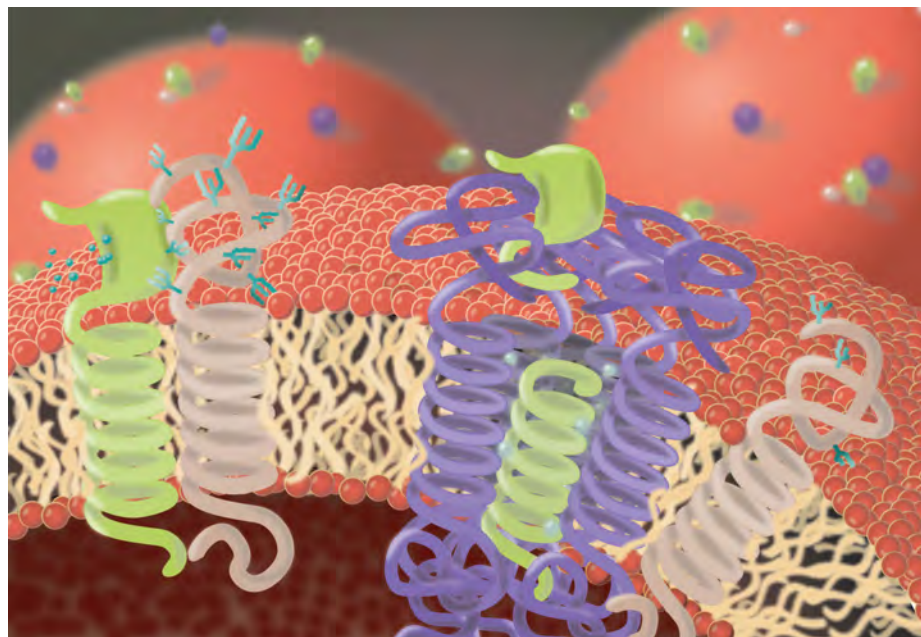
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# Intramembrane proteases: Regulators of cellular pathways

Prof Dr Regina Fluhrer from Biomedical Center (BMC), Ludwig Maximilians University of Munich (LMU) & German Center for Neurodegenerative Diseases (DZNE) shares her expertise on the field of intramembrane proteases, focussing on regulation of cellular pathways

Intramembrane proteases are proteins that form pore-like structures in cellular membranes and are capable of cleaving other membrane proteins, their substrates. According to their catalytic centres, different families of intramembrane proteases were discovered (for more details, see the [October 2018 edition](#) of Open Access Government). Their substrate proteins usually traverse the membrane once with a so-called transmembrane domain and constitute additional domains on each side of the membrane. Cleavage by an intramembrane protease within the transmembrane domain, therefore, results in the release of protein fragments to both sides of the membrane. Having lost their association with the membrane, these fragments are able to translocate to other parts of the cell where they may act as messenger molecules and transfer signals in order to regulate certain cellular processes.

The NOTCH receptor is one of these substrate proteins. It is important for many cell differentiation processes, in particular during embryonic development, but also later in life affecting many different cell types and organs including the immune system, the heart and the brain. Expressed on the plasma membrane of a cell the NOTCH receptor senses ligands expressed on the plasma membrane of another, neighbouring cell. Upon



*Regulation of protein glycosylation by SPPL3, illustrated by Charlotte Spitz*

binding of the ligand to the receptor, a proteolytic cascade, also known as regulated intramembrane proteolysis (RIP), is initiated. First, a protease cleaves the NOTCH receptor in its extracellular domain, releasing the bulk of this protein part. The leftover of the NOTCH receptor, which is still embedded in the membrane, subsequently undergoes intramembrane proteolysis mediated by presenilin, which is part of a protein complex called g-secretase (read more in the forthcoming July 2019 edition of Open Access Government). This cleavage liberates the intracellular part of the NOTCH receptor from the plasma membrane and allows its passage to the nucleus where it activates genes that, for instance, trigger cell differen-

tiation. This allows cells in a developing tissue to influence the differentiation of their neighbouring cells so that various cell types in a certain tissue, like neurons and astrocytes in the brain, can arise and form organs. Deregulated Notch signalling is implicated in the development of cancers, like T-cell acute lymphoblastic leukaemia and currently, inhibitors of presenilin are tested as potential anti-cancer drugs (read more in the upcoming October 2019 edition of Open Access Government).

The membrane system of mammalian cells not only comprises the plasma membrane, but also a variety of intracellular membranes that subdivide the cytosol in different cellular compart-





*Regina Fluhrer, professor of Biochemistry*

ments. Among these compartments, the endoplasmic reticulum (ER) and the Golgi apparatus are crucial for production and sorting of integral membrane proteins. Cholesterol is an important constituent of cellular membranes and, therefore, is required by all cells of the body. Cells can either take it up from the blood, where cholesterol resorbed from food circulates as part of lipoproteins like LDL or synthesise it themselves. The latter requires a significant amount of energy and, thus, synthesis should only take place when cholesterol retrieved from the diet becomes limited. In order to adjust the cellular cholesterol supply, the ER membrane harbours a cholesterol sensor that interacts with SREBP-2, a u-shaped protein spanning the ER membrane twice. Once cholesterol levels in the ER membrane, a place for cellular cholesterol storage, drop, the cholesterol sensor together with SREBP-2 gets transported to the Golgi membrane where SREBP-2 gets cleaved by two proteases. First, S1P cleaves within the loop of the u, producing two separate membrane bound fragments. One of these two fragments gets cleaved by S2P, an intramembrane protease. This cleavage releases a fragment, which travels to the nucleus where it induces expression of the enzymes that are required for cholesterol synthesis. S2P was actually the first intramembrane

protease discovered in 1997 and not only enlightened an important regulatory mechanism of human cells but also paved the ground for the concept of intramembrane proteolysis.

**“...protein glycosylation can be regulated via the amount of SPPL3 present in the cell – the more SPPL3 is expressed, the less protein glycosylation occurs and vice versa.”**

After synthesis about half of all proteins are modified by the attachment of sugar moieties, a process known as protein glycosylation. It is important for the function and stability of proteins and is known to affect the three-dimensional configuration of some proteins. The enzymes that transfer sugar molecules to other proteins are referred to as glycosyltransferases and localise to the Golgi membrane. Only recently, we discovered that Signal-Peptidase-Peptidase like 3 protease (SPPL3), another intramembrane protease, is capable of cleaving a variety of these glycosyltransferases within their transmembrane domain. This results in release and secretion of the glycosyltransferase domain which comprises the active centre crucial for transfer of the sugar molecules and, thus, reduces the activity of the glycosyltransferases in the Golgi (see illustration). Consequently, protein glycosylation can be regulated via the amount of SPPL3 present in the cell – the more SPPL3 is expressed, the less protein glycosylation occurs and vice versa. Protein glycosylation is important for many physiological and pathological processes, like proper signalling of receptors, cell growth, angiogenesis or tumour metastasis. Therefore, SPPL3 expression may be an attractive cellular switch to regulate such processes and, thus, has the potential to become an attractive drug target in the future.

These examples illustrate that intramembrane proteases are involved in key cellular pathways and deregulation can cause diseases for which to date no cure exists. Based on the fact that proteolytic cleavages are irreversible, it must be assumed that these proteases under physiological conditions are tightly regulated. To further pursue intramembrane proteases as promising drug targets, a precise understanding of these regulatory mechanisms is indispensable and in the focus of current research activities.

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# Tackling neurodegenerative diseases including Alzheimer's

The work of the EU Joint Programme – Neurodegenerative Disease Research (JPND) which aims to tackle the challenge of these diseases, in particular, Alzheimer's, is discussed here

The EU Joint Programme – Neurodegenerative Disease Research (JPND) is the largest global research initiative aimed at dealing with the challenge of neurodegenerative diseases, in particular, Alzheimer's. It is worth noting that this initiative is supported through funding from the European Union's Horizon 2020 Research and Innovation Programme, under grant agreements No 643417 and No 681043.

The aim of JPND is to increase coordinated investment between participating countries in research which sets out to discover the causes, developing cures and seeking appropriate ways to care for those with neurodegenerative diseases. JPND's ultimate objective is to find cures for neurodegenerative diseases and to enable early diagnosis so that early targeted treatments are possible. Having said that, JPND points out on their website that it is not possible to give definitive predictions on how long this might take to occur.

It's worth noting here that for now, JPND has identified common research goals that would benefit from joint action between countries, in their Research Strategy. The aim of this to accelerate progress on solutions that can alleviate the symptoms of neurodegenerative diseases, and to decrease the economic and social impact of it for patients, families and health care systems. This important work of JPND can be divided into the following three main components, which set out to improve:

- The scientific understanding of neurodegenerative diseases;
- The medical tools available to doctors to identify and treat it and;
- The social care and structures available to assist patients, their families and health service providers.

This enables patients to receive nothing but the optimum level of care during all stages of their illness.

## Joint Programming

I also want to point out that Joint Programming concerns new collaborative approach to research, whereby, countries come together to define a common vision, a strategic research agenda and a management structure, so that the 'grand challenges' facing EU society in the future can be addressed. It is true to say that challenges like neurodegenerative diseases, food and energy security, as well as climate change, are viewed as being beyond the scope and resources of a single country to tackle and as such, they would hugely benefit from a coordinated approach to research that benefits society.

## Neurodegenerative diseases such as Alzheimer's

Looking at the topic of neurodegenerative diseases, such as Alzheimer's and Parkinson's, are debilitating and largely untreatable conditions that are strongly linked with age. Certainly, Europe has a rapidly ageing population and according to JPND, 16% of today's European population is over 65, and this figure is expected to rise up to 25% by 2030.

Focussing on dementia, we know that this is responsible for the greatest burden of disease, with Alzheimer's disease and related disorders impacting no less than 7 million people throughout Europe. Unfortunately, this figure is predicted to double every 20 years as the population lives for longer in Europe.

In terms of the cost of dementia care across Europe, the JPND highlight that today, it costs in the region €130 billion every year to care for people with dementia, so age-related diseases are one of the leading societal and medical challenges faced by EU society.

“Looking at the topic of neurodegenerative diseases, such as Alzheimer’s and Parkinson’s, we know that all these are debilitating and largely untreatable conditions that are strongly linked with age. Certainly, Europe has a rapidly ageing population and according to JPND, 16% of today’s European population is over 65, and this figure is expected to rise up to 25% by 2030.”



Considering Alzheimer’s disease, this is especially costly to manage due to the length of time over which the condition extends itself, its insidious onset and its ever-increasing levels of disability. The average duration of this disease lasts from two to 10 years when patients will need special care that is a significant burden for societies and caregivers, JPND note.

JPND also explain that the major investments made in other diseases, such as cardiovascular disease and cancer, have resulted in significant improvements in patient outcomes and treatment. To date, JPND says that neurodegenerative diseases have not received the same level of funding, even though they have a negative impact on healthy life years. This is indeed a challenge, but as we see below, it’s not all doom and gloom.

### JPND-supported projects

In closing, it’s worth noting that many of the JPND-supported projects can lead to new scientific discoveries, which of course, have positive impacts on patients and families, not to mention opening up new possibilities for broader society, as well as industry.

Also, we know that JPND is all for transnational research projects and working groups so that researchers can collaborate across borders to tackle the global challenge of neurodegenerative diseases.

It’s a very appropriate time to highlight JPND’s plans to tackle the challenge of neurodegenerative diseases, following the 10th anniversary of the 10 JPIs (Joint Programming Initiatives) in November 2018. The fact that JPND brings together 30 countries shows that they are serious in tackling the challenge of neurodegenerative diseases, including Alzheimer’s. ■

[www.neurodegenerationresearch.eu](http://www.neurodegenerationresearch.eu)

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# Treatment and diagnosis of neurodegenerative disorders

Andrea Varrone studies the importance of molecular imaging to provide personalised medicine and improve care for patients with neurodegenerative disorders

Neurodegenerative disorders represent a heavy burden for the society at a global level. In 2015 there were 46 million cases of Alzheimer's disease (AD) and other dementias and approximately 6 million cases of Parkinson's disease (PD) worldwide<sup>1</sup>. From 1990 to 2015 the prevalence of both disorders has more than doubled and the burden for the society has increased with increasing age<sup>1</sup>. Tools for personalised medicine and improved care of patients with neurodegenerative disorders are needed, including disease biomarkers for early diagnosis, patient stratification and assessment of treatment efficacy.

The development of brain imaging tools that target specific molecules and disease processes is key to understand the pathological changes associated with neurodegenerative disorders. Accumulation of misfolded proteins such as amyloid-beta, tau and alpha-synuclein, along with synaptic dysfunction, synaptic loss and neuroinflammation are pathological processes common to major neurodegenerative disorders. Molecular imaging with positron emission tomography (PET) can facilitate the development of markers that enable to study these processes in vivo (see Figure).

Molecular imaging markers can be used as tools for early diagnosis and

patient stratification and as endpoints to assess the effects of disease-modifying treatments, thus supporting drug development programs.

## Imaging of amyloid-beta and tau, present and future

At present, several PET agents are available to image amyloid plaques in prodromal or symptomatic AD. Tau accumulation also plays a key role in the natural course of the disease. Tau imaging agents have enabled to examine in vivo the distribution of tau pathology according to Braak staging, but also the relationship between tau accumulation and neurodegeneration and between tau and cognition<sup>2</sup>. Most of the first generation radioligands, however, showed some limitations related to the presence of off-target binding<sup>3</sup>, which limits their wide application in AD and non-AD tauopathies, such as progressive supranuclear palsy (PSP) and corticobasal syndrome (CBS).

New tau imaging agents with less off-target binding are now available and show promising results in detecting tau pathology in vivo in AD and PSP. The thorough in vivo characterisation of new tau imaging agents including quantification with kinetic analysis and compartmental modelling will be key for their validation as clinical imaging agents in AD, PSP and CBS, as well as potential biomarkers for clinical trials using anti-tau immunotherapies.

## Alpha-synuclein – the molecular imaging “unicorn”

The development of an agent able to image alpha-synuclein in PD and other synucleinopathies such as multiple system atrophy and Lewy body dementia is an undisputable unmet need. Although several efforts have been made, a PET imaging agent for Lewy body pathology is yet not available. Such PET agent is of high need considering also potential therapeutic approaches to target alpha-synuclein pathology that are under development<sup>4</sup>.

## Synaptopathy – imaging of synaptic density

Alpha-synuclein pathology in PD is associated with synaptic dysfunction and degeneration<sup>5</sup>. The concept of synaptopathy is a broad term that indicates changes induced by different types of pathological mechanisms leading to synaptic dysfunction. Synaptopathy is characteristic of neurodegenerative disorders, but also of schizophrenia and autism spectrum disorders. The availability of PET radioligands for imaging the synaptic vesicular glycoprotein 2A (SV2A) enables to measure synaptic density in vivo. Reduced SV2A availability in hippocampus of AD patients<sup>6</sup> was recently reported and studies in PD and schizophrenia are ongoing. SV2A is a general marker of synaptic density, whereas SV2C is specifically expressed in the nigrostriatal system and found to be altered in PD<sup>7</sup>.

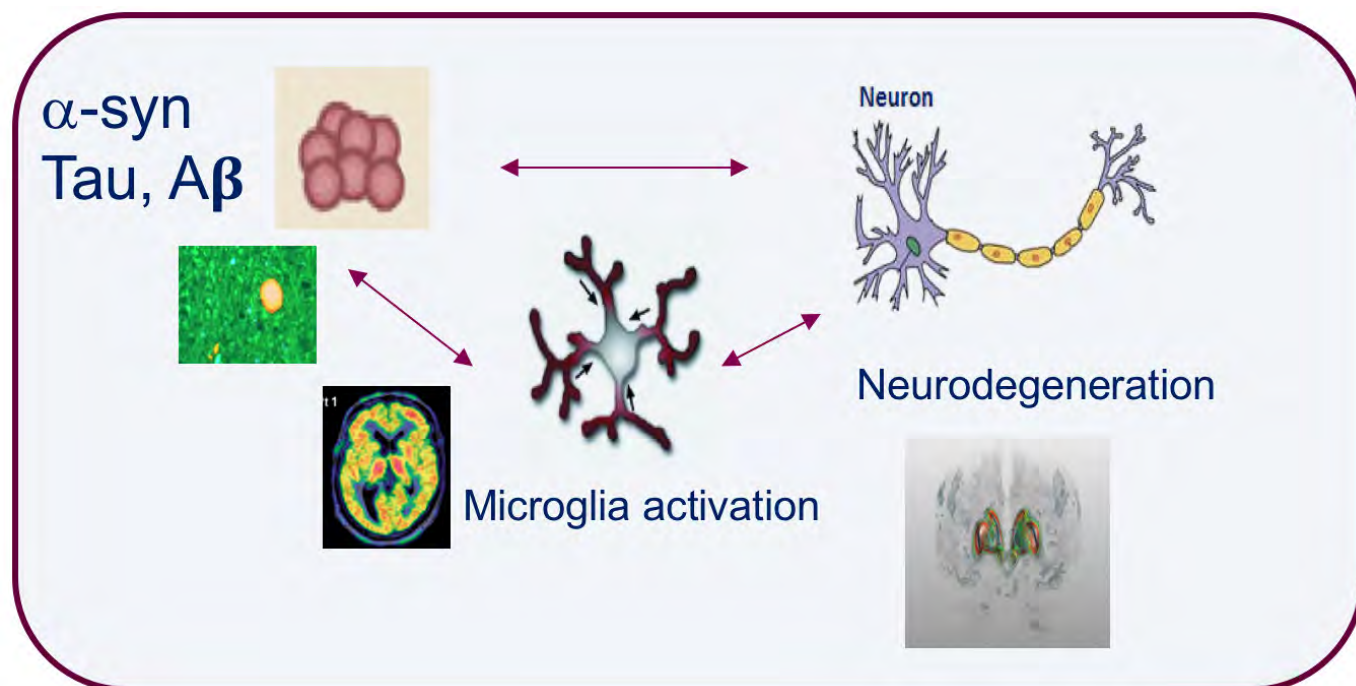


Figure. Schematic representation of the link between the three pathological processes that characterise neurodegenerative disorders and that can be imaged in vivo using positron emission tomography.

Therefore, a PET radioligand for SV2C will be more specific to study synaptopathy in PD. At present, the most straightforward approach to examine the synaptic integrity of dopaminergic terminals in PD is dopamine transporter (DAT) imaging. Studies have shown that while there is a profound loss of DAT in the dopaminergic terminals, in early PD the DAT is relatively preserved in the axons and the cell bodies<sup>8</sup>, supporting the view that synaptic loss is the earliest pathological event and that synaptopathy eventually leads to a retrograde or “dying back” like type of degeneration<sup>5</sup>.

## Neuroinflammation

Microglia activation and neuroinflammation have been of major interest for the neuroimaging community and considerable efforts have been made to find suitable PET imaging agents. The 18-kD translocator protein (TSPO) has been for decades the major target to image neuroinflammation in vivo. Initial studies with the first TSPO PET agent [<sup>11</sup>C]PK11195 reported increase binding to TSPO in AD, PD, as well as other parkinsonian disorders.

Subsequent studies with second-generation TSPO radioligands have reported different results, not necessarily replicating initial findings observed with [<sup>11</sup>C]PK11195. TSPO is not selective for microglia as it is also expressed on astrocytes. Therefore, there is a need for new targets that can be more selective for imaging microglia activation. Work on some of these new targets as the purinergic receptors P2X7 and P2Y12 is ongoing and further development is needed to identify better agents for imaging neuroinflammation in neurodegenerative disorders.

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# The latest updates on Huntington's disease research

Chief Executive of the Huntington's Disease Association, Cath Stanley shares the latest updates on Huntington's research from the 2018 European Huntington's Disease Network conference

The 2018 European Huntington's Disease Network conference took place in Vienna from 14-16 September 2018. This fantastic gathering brought researchers, clinicians, families and patient associations together to learn about the latest news in Huntington's research. In this article, I will share some updates from the conference.

The opening session of the EHDN conference was a reminder that with all the recent progress into Huntington's disease it is important to remember the history and stories that have gone before. It was pointed out that it is 25 years since the gene was isolated.

Gene therapy was the focus of the days' talks with researchers talking about both protein lowering and gene editing techniques. There was a discussion about balancing realism against hope and the importance of having hope. Researchers talked about the importance of biomarkers – these are ways of measuring both disease progression and any benefit of prospective treatment.

Further presentations focussed on keeping brain cells functioning and how we slow disease progression. Talks looked at the importance of having an enriched environment and regular exercise, which may have an impact on the progression of the disease.

The definition of Juvenile Huntington's was discussed as this can be misleading as often the person or child may be an adult when showing symptoms which have begun in childhood.

The results of the Pfizer Amaryllis and Legato studies showed that they had failed in their primary goal to improve the motor function. This is a reminder that scientific trials are just that – to test a theory that



*Cath Stanley  
Chief Executive*

something might happen. Lessons will be learned that may help further studies to become successful. On the positive side, Wave Life Sciences showed a different approach that really is cutting edge and we look forward to the outcome of the trial in patients which should hopefully be early in 2019.

The final session has created great excitement in the Huntington's community – the Ionis (now RG6042) trial and Roche Pharmaceutical's announcement of the beginning of the recruitment of over 600 patients worldwide for the phase 3 trial. Trial sites have not yet been identified. RG6042 has the potential to provide clinically meaningful effects on disease progression in people with Huntington's. This is just the beginning and there may be challenges along the way but there is now a real optimism within the Huntington's community. ■

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# Providing a path to advanced degrees in biomedical fields

The NYU Sackler Institute of Graduate Biomedical Sciences aims to train the next generation of scientists to make breakthroughs and advances in society at large, explains Naoko Tanese

Becoming an accomplished researcher requires an inquisitive mind and perseverance. It calls for hands-on research experience and active mentorship. Sackler students receive rigorous training to become independent scientists. We also instil in them a strong sense of social and ethical responsibility through interactions with our diverse research community.

## PhD programme

Students matriculating at NYU Sackler Institute of Graduate Biomedical Sciences begin their training in an Open Program. While some students enter graduate school with a speciality in mind, in the Open Program students are encouraged to explore multiple fields. First-years wait to select a training discipline until they have taken several courses, completed two or three laboratory rotations, and selected a faculty mentor for their PhD thesis work. They have a full year to make final decisions.

We recently expanded the scope of our program to include new training tracks in Biomaterials Science, Biostatistics, and Epidemiology, in addition to all of the existing traditional disciplines in biomedical sciences. As we recruit students interested in the new tracks, we are faced with balancing the unique background of each student with the spirit of the Open Program. How can the curriculum of an

Open Program satisfy students with varying interests and backgrounds?

To address this challenge all incoming students are required to take the course Introduction to Research, which starts immediately after Orientation with an immersive lab experience called Research Adventure. The Introduction to Research course is intended to not only help incoming students begin graduate school with the same basic knowledge, but also to provide them with a sense of community.

The Research Adventure is an intensive, week-long, hands-on research experience, where students working in a team carry out a structured project in a faculty's lab on a topic different from their previous research. This exposes them to new possibilities that perhaps they may not have considered. We continue to evaluate best practices to keep the spirit of the Open Program alive while accommodating the different interests and backgrounds of our matriculating students.

## Career

In higher education, there is an increasing trend for PhD students to pursue alternative careers (non-academic positions). For this reason, we strive to prepare them for any career. We emphasise how PhD training teaches students to be critical thinkers, problem solvers, productive team members,

collaborators, independent workers, and effective leaders. These are qualities useful to any career path.

NYU's centre for career development offers services such as resume and cover letter preparation as well as networking and interviewing practice sessions. Students participate in many job and internship fairs. We also invite alumni back to give career talks and meet with students to discuss their experiences.

Our students also take advantage of a variety of workshops and courses offered by the postdoctoral affairs office. To improve their career training, they actively engage in career planning while assessing their personal values and translating them to individual goals. They are introduced to all the diverse career opportunities outside of academic research. For those interested in teaching, students learn how to design and implement courses both at the college and post-graduate level. Communication is another skill critical to any career. We host workshops and seminars to help our students with their communication skills, both written and oral, to a variety of audiences.

## Inspiring the next generation

The future of our society depends on training the next generation of highly capable scientific workforce. For this



*Participants of the Sackler Institute's Summer Undergraduate Research Program*

reason, we place a great deal of effort in mentoring young people interested in pursuing careers in science. We are increasingly wary of losing students' interests in STEM – Science, Technology, Engineering, and Mathematics. We are also concerned that not enough young people from diverse backgrounds are entering the STEM field. The current makeup of scientists in biomedical fields does not reflect the composition of the US population.

Numerous studies have reported the benefits of a diverse research community in advancing scientific endeavours. We are committed to making this happen by reaching out to students from diverse racial, ethnic, and socioe-

conomic backgrounds. One mechanism that has been in place at the Sackler Institute is our Summer Undergraduate Research Program (SURP).

Established in 1990, the SURP has been one of the cornerstones of minority recruitment for MD, PhD, and MD/PhD programs. The purpose of SURP is to give students who have the interest in biomedical sciences an opportunity to conduct research at a major medical centre. Over 700 students have participated in this program and >95% of the participants subsequently entered graduate or professional degree programs. We make an effort to provide a supportive community where students from all

backgrounds feel at home. This is critical to our mission to promote diversity and inclusion at the Sackler Institute.

In many ways, STEM training needs to start earlier than college. We have been reaching out to students in nearby high schools to introduce them to scientific research. It's never too early to show them what it's like to be a grown-up scientist. We have visited local schools to give presentations and met one-on-one with young students. We have invited them to research laboratories to observe scientists at work, and in some cases perform experiments as student interns.

Ambitious and determined students commit to commuting long distances for these hard-to-find opportunities to satisfy their curiosity and challenge themselves to unfamiliar but exciting tasks. Some students never give up looking for a chance to enter research labs. This makes it worthwhile to mentor and see them thrive in a new environment. Scientific discoveries are made by following one's passion. We are here to inspire young people to find their passion in the biomedical sciences.



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# Reducing the burden of neurological disease: A focus on stroke research

Open Access Government looks at the wider work of The National Institute of Neurological Disorders and Stroke in the U.S. when it comes to reducing the burden of neurological disease and how they are supporting stroke research

**T**he National Institute of Neurological Disorders and Stroke (NINDS) is an Institute within the National Institutes of Health (NIH) in the U.S which seeks to gain fundamental knowledge about the brain and nervous system to reduce the burden of neurological disease. <sup>(1)</sup>

The current Director of the new Division of Neuroscience is Lyn Jakeman, PhD, appointed in October 2018. When appointed, she painted a very positive picture of neuroscience research. “We are in the midst of amazing technological and analytical advances that are rapidly accelerating the pace of discovery in fundamental and applied neuroscience research”, she said <sup>(2)</sup>

## A balance of basic, translational and clinical research

Going into further detail, we know that NINDS fosters a balance of basic, translational and clinical research. Indeed, it is said that scientists and physicians in academia and industry agree that basic research is crucial for long-term progress against neurological diseases. In essence, basic research aims to help us understand how the nervous system develops and works and what goes wrong in disease.

While the private sector in the U.S. supports little basic neuroscience research because the return on investment in this type of research is unpredictable, the NIH, therefore, supports most basic medical research in the U.S in this field.

Following on from this, it's worth noting that NINDS basic research is divided between research on the normal development and working of the nervous system, plus research related to disease mechanisms.

The cluster organisation of the NINDS extramural program focuses on the following areas, amongst others: neurodegeneration, such as shared mechanisms of nerve cell death that contribute to many diseases; the control of the environment of nerve cells by supporting cells; systems and cognitive neuroscience, including attention, thinking, sensation, perception, movement, learning, memory and emotion; as well as the role of genes in the normal and diseased nervous system; nervous system repair and plasticity, such as neural prostheses, stem cells, and regeneration. Maintaining this remarkable breadth of basic research is essential to the Institute's mission. <sup>(3)</sup>

When it comes to NINDS Division of Translational Research (DTR), we know that they provide funding and resources (approximately \$100 million annually) for neurological disorders and stroke through grants, cooperative agreements, and contracts to academic and industry researchers to advance early-stage neurological technologies, as well as therapeutic programmes to industry adoption and devices. <sup>(4)</sup>

## Stroke research

There are many examples of NIH-funded stroke research that we read about online, such as this [NIH-funded trial](#) which finds a lower rate of secondary stroke but a small risk of bleeding, and how preliminary research results suggest that [strokes also affect the eye](#).

Let's, however, take a look now at a more recent example, an NINDS funded study that suggests a change in diet could mitigate increased risk for stroke. These recent research findings suggest that diet is a major contributor to the increased risk of hypertension in black compared to white Americans.

We find out that the results, published in the Journal of the American Medical Association, examine the incidence of stroke in around 30,000 individuals. "This study addresses a lead cause of racial disparity in mortality and identifies potential lifestyle changes that could reduce racial disparities in both stroke and heart disease," says Claudia Moy, Ph.D., NINDS program director and one of the authors of the study.

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**"We are in the midst of amazing technological and analytical advances that are rapidly accelerating the pace of discovery in fundamental and applied neuroscience research."**

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In the study, researchers looked at individuals over the age of 45 over a period of 10 years and sought to identify risk factors associated with the higher likelihood of developing high blood pressure in the study participants. George Howard, a biostatistics professor at the University of Alabama, Birmingham gives his own thoughts on the study: "The majority of disparities we see in the health of black versus white Americans are cardiovascular in nature and of these, all are tied to an increase in high blood pressure."

We find out that a diet consisting of high amounts of fried and processed foods, as well as sweetened beverages, was the greatest factor as to why blacks are at a greater risk of developing high blood pressure compared to whites, for both sexes. Important factors for men and women include salt intake and education level. For women, extra factors contributing to the racial difference in high blood pressure included waist size and obesity.

"One of the main factors affecting the difference between the black and white population is cardiovascular disease, and the increased risk of high blood pressure among black Americans could help explain why their life expectancy is four years shorter than that of whites," says Dr Howard. "Understanding how we can prevent this increased risk of hypertension in blacks is critical for reducing health disparities among the black population", he adds.

As this article comes to a close, we know that these researchers hope that these findings might be applied to reduce the prevalence of hypertension and, therefore, the risk of stroke and heart attack in the black American population. This study recommends that lifestyle changes, such as changes in diet, could help to lower the disparities evidenced in black versus white Americans.

The last word goes to Dr Howard, who provides a very sensible piece of advice on how to treat high blood pressure. "The best way to treat high blood pressure is to prevent it from occurring in the first place," states Dr Howard. <sup>(5)</sup> ■

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# Stroke recovery research: The exciting trends of the future

Steven A. Kautz, Professor at the Ralph H. Johnson VA Medical Center and the Medical University of South Carolina College of Health Professions gives a glimpse into the future trends for stroke recovery research

There is a crucial need for research into recovery from a stroke that leads to improvements in the long-term quality of life of those who have suffered a stroke. The term “Recovery from Stroke” almost always describes an incomplete process that includes compensatory behaviour and modified neural circuits rather than recovery of the function of pre-morbid neural tissue. This term broadly describes events, such as recovery of damaged neural tissue by neuroprotection, recovery of damaged neural circuitry by reorganisation, recovery of behaviour through rehabilitation, and recovery of quality of life through increased participation in daily living activities.

Most stroke research focuses on acute treatment or prevention within hours or days after stroke, with research to help those with chronic disabilities after stroke having long been underemphasised. Current understanding of how the nervous system repairs and reorganises neural circuitry (i.e., neural plasticity) to promote behaviour, and how neural plasticity can be harnessed to maximise recovery of behaviour through rehabilitation, is inadequate. There is a pressing need to conduct animal and human studies to improve understanding of the mechanisms involved in functional behavioural change and neural plasticity induced by interventional studies, and build a framework

to help researchers develop more efficacious, evidence-based interventions.

Such studies will help identify the neural substrates and processes underlying specific behaviours and recovery of these behaviours after stroke, including translational studies in which we model human studies in animals with complementary intervention and measurement paradigms. Multidisciplinary translational research into stroke recovery is of special importance to the people of my state of South Carolina in the U.S. due to their disproportionate rate of stroke and the economic and societal burdens of resulting post-stroke disabilities.

I believe that better understanding of the experience-dependent nature of neural plasticity will allow researchers to investigate and exploit inherent neural recovery processes, develop and translate novel mechanism-based interventional strategies and ultimately, improve the function and quality of life of individuals recovering from a stroke. Currently, outcomes following stroke are suboptimal because of major gaps in foundational understanding of the neural circuitry (substrates and processes) underlying behaviour, as well as their repair and reorganisation (i.e., neural plasticity).

While the translation of methods to augment plasticity inspired by basic

science knowledge holds exceptional promise for advancing the field, rehabilitation interventions will necessarily play a central role in advancing recovery from stroke. Even if the highest hopes for cell-based therapies (i.e., neural repair by stem cells), pharmaceuticals or other adjuvant methods of enhancing neural plasticity, such as invasive or non-invasive brain stimulation techniques are realised, rehabilitation will be crucial as the behavioural engine to ‘teach’ the new neural circuitry to perform the necessary functions. Thus, a major focus of current research is to develop and test novel methodologies for performing and augmenting rehabilitation interventions, based on principles consistent with the mechanisms of experience-based plasticity in the nervous system.

I am fortunate to direct a talented team of multidisciplinary researchers at the NIH-funded Center of Biomedical Research Excellence (COBRE) in Stroke Recovery, a collaboration between the Colleges of Health Professions and Medicine at the Medical University of South Carolina in Charleston, South Carolina. The initiative is supported by the NIH’s Institutional Development Award (IDeA) program put in place to promote, augment and strengthen the biomedical research capabilities of institutes in IDeA states. I believe that there are four aspects of our centre that offer insights into the future of stroke recovery research.



## Four insights into the future of stroke recovery research

First, multidisciplinary team science is the clear future of stroke recovery research, and these teams should include both clinical and basic scientists. Our centre includes teams with experts in rehabilitation, neuromodulation, statistics, bioinformatics, neuroimaging and neuroscience. In addition, those teams include scientists from the clinical professions that are on the front lines of stroke recovery and rehabilitation – stroke neurologists, physical therapists, occupational therapists, speech-language pathologists, neuropsychologists and psychiatrists, among others.

Second, neuromodulation offers incredible opportunities for application to stroke recovery. Stroke is a disease that affects the nervous system. After the stroke, there are neurons that have died. However, the deficits do not just result from the loss of those neurons, but also from the changes induced in all of the neural circuits and pathways in which those neurons participated. Neuromodulation offers a potential methodology to modify aberrant circuits and improve, or even restore, some of the post-stroke deficits negatively impacting the quality of life. The BRAIN initiative at NIH has led to the development of a number of new tools that allow researchers to better understand how to modify neural circuits. That many of these neuromodulation methods use electricity directly at the aberrant circuit, instead of pharmaceuticals delivered systemically, offers the promise of an approach with greatly reduced potential for side effects.

Third, a better understanding of the experience-dependent nature of neural

plasticity and its translation into clinically effective interventions will be crucially facilitated by the development of a theory-based measurement framework that includes quantitative behavioural, neurophysiological and imaging based measures of:

- 1) Normal neurological function;
- 2) Underlying structural and functional damage after stroke;
- 3) Experience-dependent neural plasticity during rehabilitation;
- 4) Structural and functional changes post-rehabilitation and;
- 5) The functional recovery of each individual patient.

Fourth, comprehensive multidisciplinary databases enabled by data sharing between studies and between centres offer incredible promise for tackling the difficult problem of determining which treatment or treatments are needed for each stroke survivor. Stroke is heterogeneous and recovery is likely to need to be personalised to the specific deficits and available neural substrates of each individual. Thus, there is a need for a theory-based measurement framework and the data from multidisciplinary domains like imaging, neurophysiology, behaviour, cognition, language, etc. in order to better define the various phenotypes of stroke recovery – what has been called dense phenotyping. The ultimate goal is to connect this dense phenotype data with the electronic health-care records and genomic data.

This is an exciting time in the field of stroke recovery as these emerging

trends leave researchers well positioned for breakthroughs that can truly improve the quality of life for stroke survivors. Research centres, such as our COBRE and others throughout the world are assembling innovative multidisciplinary research teams, testing promising technology like neuromodulatory devices, and sharing data to assemble rich multidisciplinary data sets to allow dense phenotyping. I foresee great progress in personalised stroke recovery in the next decade.



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# Biomarkers and patients' access to personalised oncology drugs in Europe

Heinz Zwierzina M.D., CDDF Managing Director tells us all about biomarkers and patients' access to personalised oncology drugs in Europe in this insightful article

It is becoming evident that the more we know about microbiology, the more complex drug development becomes. Histopathologically well-defined tumour entities become multiple different diseases classified by genetic alterations. These may differ from one cancer type to another and the ones we commonly see in, for example, lung cancer aren't always the ones we see in breast or colorectal cancer. Another issue is that usually, there are only a very small number of patients with a particular mutation. Thus, we will need to adapt the way we design clinical trials to show whether a specifically targeted drug is effective in a very small patient population.

Biomarkers can be objectively measured and evaluated as indicators of normal or pathogenic biological processes or of pharmacologic response to therapeutic interventions. As such, biomarkers hold great potential to predict clinical outcomes and define a personalised treatment strategy. Given the complexity of the neoplastic process, in most instances, a single marker cannot offer the necessary sensitivity and specificity. Therefore, research is now focussed on the development of multiplexed assays that screen multiple genes and proteins at the same time.

## The need for collaboration among all stakeholders

There is a huge clinical need for minimally invasive tests to determine the subgroups of patients with a high probability for (non-)response to therapy. Moving to the future, it will be very important to move from sporadic testing of patients to 'real-time oncology', using novel biopsy methods (such as liquid biopsy) to meet the challenges of repeated biopsies, and also leverage big data analyses, as well as artificially supported intelligence and machine learning. This should integrate the

continuous assessment of key genomic, epigenetic and proteomic analysis, describing the disease, the micro-environment and the interaction, along with measurement of real-time impact for any modification in treatment. This should help understand the sources of variability in a medicine's benefit/risk profile.

Regulatory challenges, the hurdles to achieve reimbursement, and access to clinical data are all barriers that will need to be further addressed by all stakeholders to achieve the widespread use of biomarkers in clinical practice in future. Although small compared to the costs of oncology drug development, the development, validation and commercialisation of biomarker assays are expensive. Therefore, in order to realise the potential value from biomarkers, early dialogue between industry, regulators and payers is very important.

The [Cancer Drug Development Forum](#) (CDDF) recognises the complex issues of integrating biomarker development into innovative oncology drug development. It organises and encourages multi-stakeholder meetings and workshops among academia, the pharmaceutical industry, regulatory authorities, health technology assessors, patient organisations, as well as payers to address these challenges.

## Health Technology Assessment (HTA) and patient access

From the healthcare system perspective, access to biomarkers that define the patients that may or may not respond to therapy will be crucial to improving treatment standards and efficiency of care. However, the reimbursement of biomarker testing varies from country to country. For example, the K-ras testing is reimbursed at significantly varying rates across the EU Member States.



The key challenges for biomarker testing in Europe are:

- Accessibility of biomarker testing varies from country to country, but also within cities and regions. Biomarker diagnostics are often performed at larger hospitals only, access to which may add additional barriers to timely diagnosis.
- Administrative barriers lead to delays and longer waiting periods for biomarker test results, which vary from a few days to a month in some countries. There is no established organisation between hospitals to perform a test and share the results of these tests effectively.

At a European level, there is a need to promote research and development in biomarkers, adapt regulatory frameworks to the specificities of new health technologies, and harmonise HTA across the Member States. At the national level, there is a need to train healthcare professionals and patient advocates on the importance of biomarker testing, and to adapt reimbursement frameworks to the specificities of new health technologies. Lack of consistent HTA processes across Europe create a barrier to entry for novel diagnostics because they require a significant additional investment from diagnostics companies to navigate the payer landscape.

## The way ahead

The close collaboration between the Cancer Drug Development Forum (CDDF) and the European Cancer

Patient Coalition (ECPC) aims to raise awareness and educate patients/policymakers regarding biomarkers and personalised medicine. Biomarker testing holds value for facilitating faster diagnosis, a targeted personalised treatment plan, and avoid wasting resources on ineffective treatments.

Innovative access strategies are required to support rapid reimbursement and adoption of biomarkers in clinical practice. Finally, only a multistakeholder approach can ensure the attractiveness of Europe as a market for the development and launch of oncology biomarker tests. ■



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# A trans-disciplinary approach to cancer research

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**T**umors are extremely complex systems, involving biological interactions of pathological and normal cells with the extracellular biochemical microenvironment, where all important transport processes, such as nutrients delivery and waste removal, play a key role as well. Recapitulating all these factors into a comprehensive modelling framework is a formidable task in cancer medicine.

Different research approaches are typically proposed, including *in-vivo*, *in-vitro*, *in-silico*, and mathematical

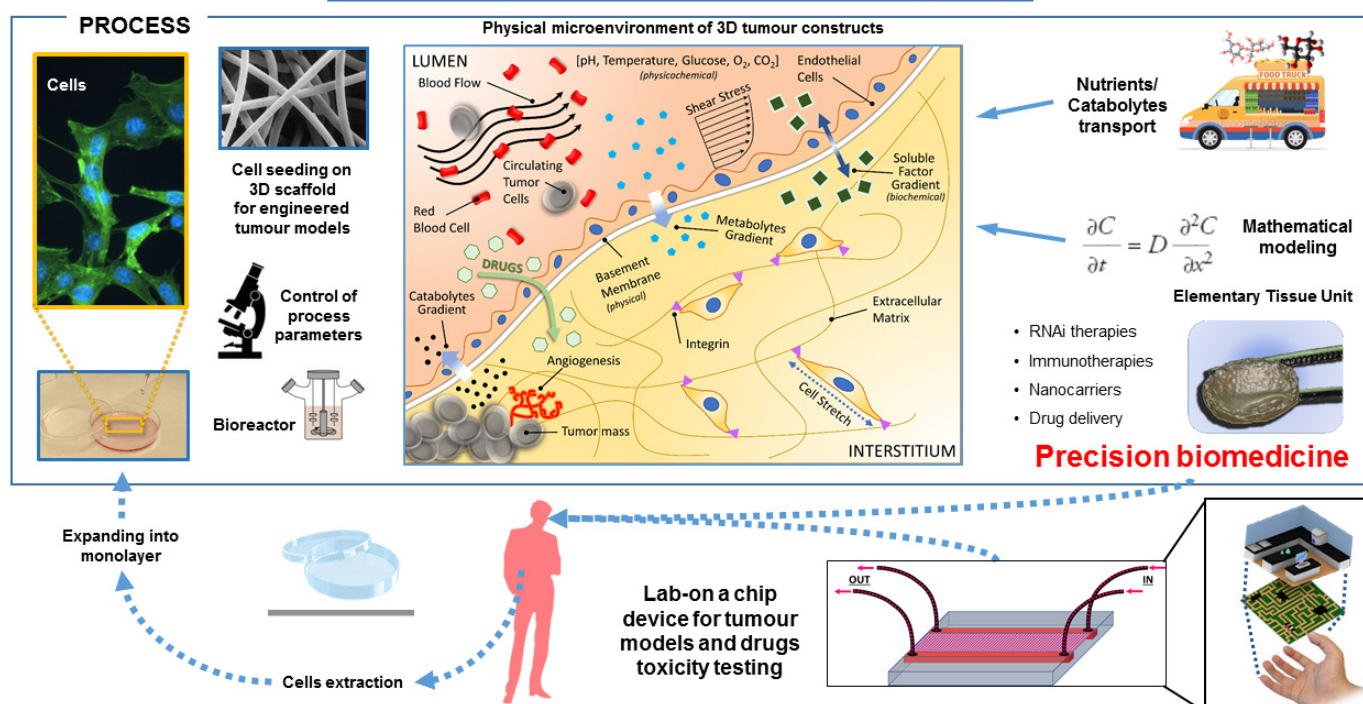
models to study cancer growth and treatment. Each of these methodologies alone can only provide and examine a partial description of the interplay between complex microenvironment and drug transport efficiency, and hardly allows to provide patient-specific information, to be used to design personalized precision treatments.

We believe a trans-disciplinary experimental-theoretical approach needs to be implemented to identify quantitative mechanistic correlations between

tumor stromal/microenvironmental parameters and cell behavior. The results will provide insight on resistance factors that limit drug delivery for cancer therapies, and suggest the design of novel nano-carriers to enhance drug transport and release by integrating *in vitro*, theoretical, and *in vivo* models, superior to any actually existing experimental approach.

We are developing a novel Elementary Tissue Unit (ETU) based on spatial and temporal microfluidic technology integrated with *ex vivo* 3D co-cultures and

## Lab-on-Chip platform for Tumour models (LOCT)



advanced mathematical modelling, enabling us to deliver the full potential of each technology and their combination toward predictive precision medicine. We have set up 3D cultures of patient-derived breast cancer organoids. The latter are miniature forms of tissues that exhibit three-dimensional architecture and are able to maintain phenotypical properties when cultured in a dish.

The proposed integrated experimental-theoretical approach overcomes the limitations of typical *in-vivo*, *in-vitro*, *in-silico* models, when taken alone, since it is based on a highly interdisciplinary collaborative effort of engineers, mathematicians, biologists, chemists and oncologists exceeding research activities that can be offered by each expertise individually.

Advanced mathematical models can be used to abstract key parameters responsible of the description of cancer growth, evolution and treatment. The same parameters can be reproduced in an *ex-vivo* model, where advanced microfabrication techniques can be used to reproduce the microenvironment surrounding elementary tissues in the patient body mimicking the human *in-vivo* environment. The engineered ETU will reproduce the complexity of cell microenvironment present *in-vivo* and will be specifically designed to investigate the biophysical barriers affecting drug transport, including convective and diffusive gradients limiting cancer drug perfusion, as identified and predicted by the advanced mathematical models. The ETU will include extracellular matrix and blood vessels models, and host *ex-vivo* co-cultures of tumor and healthy cells, directly from the patient, allowing to study tumor-stroma interactions. ETU can be also

used to evaluate the patient specific response to novel drug carriers.

As targeting moieties for active drug transport through nanocarriers, we developed aptamer ligands for trans-membrane receptors overexpressed on the cancer cell surface. Indeed, aptamers have easy synthetic synthesis and modifications to improve their pharmacokinetics (stability and biodistribution) and pharmacodynamics (toxicity and immunogenicity), and show an improved tissue penetration. The functional effects of treatments is experimentally determined by measuring morphological and chemical parameters and will be fed to the mathematical models developed. The output of this analysis will be used to identify the controlling barriers to drug transport and to optimize nanovector design.

In other terms cancer and healthy cell samples taken from the patient can be grown in the ETU. Since ETU mimics the environment originally surrounding the tissue sample, the cancer will develop *in vitro* following the same trends, as in the human patient. Quantitative analysis of tumor growth, invasion, and response to external stimuli, such as specific controlled therapies, can provide a measurement of key physico-chemical parameters, able to instruct advanced mathematical models. The models can be finally used to predict the response of patient to therapies.

Similar approach is typically applied in the engineering design of complex processes, such as the design of complex industrial plants or complex mechanical equipments, such as a modern, advanced vehicles. In the engineering approach, mathematical models are used to suggest lab-scale

experimental models and tests, that can be also a simplified version of the final product, but still contain all the key parameters needed to provide information relevant to the final design of the product. The final result is a non trivial scale-up from lab to full scale.

In the approach we are here proposing the final result will be to design a complex, patient specific, precision therapy.

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# The advancement of cancer research for the public benefit

The mission of the European Association for Cancer Research (EACR) to advance cancer research for the public benefit is placed under the spotlight here by Open Access Government

**T**he European Association for Cancer Research (EACR) is a professional membership association for those who work and study in the field of cancer research. With no less than 10,000 members globally, their clear mission is simply: “The advancement of cancer research for the public benefit: from basic research to prevention, treatment and care.”<sup>1</sup>

The society aims to foster communication and collaboration between its community of members, for example, by organising conferences. EACR realise just how important conferences are to help researchers share their findings and build on their knowledge but finding funding to attend events can be very difficult,

particularly for early-career researchers. That is why they strongly support the idea of bursaries to funds early-career members to take part in conferences.<sup>2</sup>

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*“The knowledge accumulated over decades about how the immune system functions at the molecular level has resulted in effective immunotherapies for cancer patients who previously had no therapeutic options.”*

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In addition, raising the profile of cancer research in Europe and to argue the case for sustained political and economic support, are two crucial elements of EACR’s work.



Founded in 1968, supporting the cancer researchers who play such an important role in fighting the disease has not diminished in its importance for EACR. Certainly, cancer researchers have been at the heart of many lifesaving breakthroughs, such as the identification of oncogenes and tumour suppressor genes, as well as the sequencing of genomes that together, have paved the way towards targeted therapies, for example, against chronic myeloid leukaemia (CML).

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**“The EACR believe that while a research career in the field can be hard, it can also be remarkably exciting and rewarding, particularly when one realises that one is a part of the wider picture. The EACR is of the opinion that a strong, open, cross-border scientific community is important now more than ever, and as such, they strongly encourage Travel Fellowships that fund early career researchers to develop their careers by visiting labs elsewhere.”**

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Recent knowledge accumulated over the decades about how the immune system functions at the molecular level have resulted in effective immunotherapies for cancer patients who previously had no therapeutic options available to them. We find out more about advances in cancer research on EACR's website, as quoted below.

“More recently the knowledge accumulated over decades about how the immune system functions at the molecular level has resulted in effective immunotherapies for cancer patients who previously had no therapeutic options. Basic research also paved the way to new ways to diagnose and monitor cancer non-invasively, using simple blood tests. Very rarely are these breakthroughs made by a ‘lone genius’ – they come about due to the hard work of many scientists, many labs, and many scientific discussions, disagreements, results and replications.”

The EACR believe that while a research career in the field can be hard, it can also be remarkably exciting and rewarding, particularly when one realises that one is a part of the wider picture. The EACR is of the opinion that a strong, open, cross-border scientific community is important now more than ever, and as such, they strongly encourage Travel Fellowships that fund early career researchers to develop their careers by visiting labs elsewhere.

Looking to the future, EACR has exciting plans, indeed, they want to help cancer researchers build the career they deserve in academia and industry. EACR also are aware that research has no borders and will vehemently defend this concept and help researchers to make their voice heard.<sup>3</sup> ■

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# ChiLTERN: A European project to improve the outcome of children with liver cancer

In this analysis, Professor Keith Wheatley tells us about The ChiLTERN project, the most comprehensive research study ever undertaken in children's liver cancer

**T**he Children's Liver Tumour European Research Network (ChiLTERN) is an ambitious five-year project that will define effective healthcare interventions in children's liver cancer, increase our knowledge of the biology of the disease and improve surgical outcomes. It is funded by the European Union's Horizon 2020 programme and coordinated by the University of Birmingham, UK, with Professor Keith Wheatley as the Project Coordinator.

There are two types of liver cancer in children: hepatoblastoma (HB), which occurs predominantly in children (especially under the age of three) and young adults, and hepatocellular carcinoma (HCC), which is much rarer in children and occurs mainly in teenagers. Treatment of HB usually requires chemotherapy, followed by surgery to the affected part of the liver or liver transplantation. The prognosis for children with HB is very good, with over 90% surviving. HCC tends to be more difficult to treat, since tumours are often large and may have spread at the time of presentation meaning that surgery may not be possible, leading to fewer than half of children with HCC being cured.

The project is divided into seven work packages (WPs), the first of which relates to the management of ChiLTERN and involves Project Manager Lou Woodall overseeing ChiLTERN from an administrative perspective.



WP2 is the PHITT trial (lead: Bruce Morland, Birmingham, UK). Patients are divided into six main groups – four HB and two HCC – with randomised comparisons in four of these groups. Low-risk HB patients who are resectable after two courses of cisplatin therapy are randomised between receiving four further courses – the current standard – or just two more to determine whether a total of four courses of cisplatin is just as effective as six courses, but leads to less toxicity. Intermediate-risk HB patients are randomised to receive one of three different chemotherapy regimens: the current European standard, the current American standard or single-agent cisplatin. High-risk HB patients – those with metastases at diagnosis who fail to respond to their initial induction chemotherapy – are randomised between two novel drug regimens.

HCC patients fall into two groups; resectable and unresectable disease. Patients with unresectable disease are randomised between standard treatment (cisplatin, doxorubicin, sorafenib) and a regimen that also includes gemcitabine and oxaliplatin.

The PHITT trial is now open in six European countries – the first patient was entered from the UK in November 2017 – and will open in eight other European countries. The SIOPEL group has been running clinical trials in Europe for many years and, around the world, other groups such as the Children's Oncology Group (COG) in the U.S. and the Japanese Children's Cancer Group (JCCG) also run trials. Given the rarity of HB and HCC in children, it is sensible for these groups to come together and collaborate in order to undertake larger and, hence,



Professor Keith Wheatley

more reliable trials. This is what is happening with PHITT and the trial is also now open in the U.S. and Japan.

**“ChiLTERN is a European network that will undertake the largest clinical trial ever in children’s liver cancer, along with associated laboratory projects and a surgical study. A project as large and complex as ChiLTERN requires input from many different people with a wide range of expertise.”**

WP3 (lead: Càrolina Armengol, Barcelona, Spain) involves biology studies and will create the first European biorepository of biological samples and provide a panel of validated diagnostic and prognostic biomarkers. One objective is to decipher the biology of liver tumours to understand why they arise in children and to distinguish different cancer subtypes according to their molecular traits, which could explain differences in prognosis. Experimental models are also being established that reproduce the broad spectrum of human disease to assess the anti-tumour effects of new drugs against specific molecular targets.

WP4 (lead: Beate Häberle, Munich, Germany) will validate the current prognostic index created by an international group called the Children’s Hepatic Tumours International Collaboration (CHIC), which previously analysed data from several HB studies in order to produce a prognostic index. Additionally, relevant parameters from the biomarker studies in WP3 will be incorporated to create an improved prognostic index. It is hoped that this will lead to improved treatment by enabling therapy to be chosen based on the molecular tumour traits of each patient, as well as clinical and pathological features.

WP5 (lead: Steven Warmann, Tübingen, Germany) will evaluate a novel surgical planning system that seeks to improve the accuracy of the operation and, thereby, surgical outcomes.

WP6 (lead: Gareth Veal, Newcastle, UK) will identify novel biomarkers of toxicity to predict children who may have an increased risk of developing toxicity, which is a major drawback to current treatment and can lead to serious long-term effects including hearing loss, kidney toxicity and impairment of heart function.

WP7 concerns dissemination and communication of the project’s outputs. As well as involving the clinical and academic communities, patient and public involvement (PPI) is an important part of ChiLTERN and a PPI group to advise on issues that are important to patients and their families is being established.

In summary, ChiLTERN is a European network that will undertake the largest clinical trial ever in children’s liver cancer, along with associated laboratory projects and a surgical study.

A project as large and complex as ChiLTERN requires input from many different people with a wide range of expertise – academic clinicians, trials methodologists and statisticians, laboratory scientists, surgeons, trial management staff, doctors and nurses in participating hospitals – who have all come together to improve the outcomes for paediatric liver cancer.



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**ChiLTERN**

Children’s Liver Tumour  
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# Point-of-care devices technology for therapeutic drug monitoring in cancer treatment and beyond

DIACHEMO is a European project developing a platform technology for point-of-care devices for chemotherapeutics and other drugs, as Christian Siebel and Dott.ssa Bianca Posocco, medical experts of the consortium detail here

Today, the drug dose given to a patient for treatment is mainly calculated on the basis of easily accessible parameters like the body surface. This dose determination, unfortunately, does not take into consideration features such as individual metabolism and, therefore, can lead to highly different concentrations of the drugs in the blood of the patient.

The idea of treatment individualisation on the basis of drug concentration measurement, interpretation and subsequent dose adaptation was first introduced in clinical practice during the 1960s for the administration of the antiepileptic phenytoin. Since then, therapeutic drug monitoring (TDM) approaches have been progressively applied to a variety of drug classes among others antiepileptics, antidepressants, cardiovascular drugs, immunosuppressants or antibiotics. In principle, the concept of TDM aims to control for pharmacokinetic variability among patients which might otherwise lead to substantial variations in systemic drug exposure. Using plasma drug concentrations to manage the treatment regimen for each individual patient is thought to optimise the therapeutic outcome by improving treatment efficacy and/or reducing toxicity.<sup>1,2</sup>

TDM could be of particular value in anticancer therapy considering the potentially fatal consequences of

inappropriate drug administration in cancer patients where under dosing might be associated with therapy failure, whereas overdosing might increase the risk of serious toxic side effects. However, though the therapeutic outcome might be improved, TDM has been rarely implemented in cancer chemotherapy. Methotrexate is the only cytostatic where TDM is routinely used to adapt the dose of the antidote leucovorin. In acute lymphoblastic leukaemia trials, the activity of asparaginase has been monitored to detect immunological silent drug inactivation.<sup>3,4</sup> Most obviously, successful implementation of TDM requires, *inter alia*, an established relationship between the drug exposure and its therapeutic and/or toxic effects which then culminates in the definition of a target exposure range.

Establishing such a relationship is particularly difficult in cancer chemotherapy owing to an imperfect understanding of the pharmacokinetic (PK) and pharmacodynamic (PD) properties of many drugs, the long lag time between concentration measurement and therapeutic outcome or late toxicity, respectively, as well as the broad use of combination chemotherapy regimens.<sup>5,6</sup>

However, a critical limitation for obtaining meaningful PK/PD data constitutes logistical requirements as the

availability of appropriate equipment, assays and trained personnel. To make TDM work, correct sample collection, sample processing, as well as highly sensitive, accurate and precise analytical methods are mandatory. The avoidance of errors during these processes is fundamental for a valid analysis and interpretation of PK/PD data.

Furthermore, analytical methods used for routine monitoring have to be fast, easy to use and widely applicable to facilitate the conduct of PK/PD studies and the transfer of TDM approaches in routine clinical practice.<sup>3,5,7</sup> These requirements are often not satisfactorily met by current analytical procedures which are frequently laborious and may involve well-equipped laboratories, the shipment of samples and complex sample processing steps.

Doxorubicin and paclitaxel are two commonly used chemotherapeutics which exemplify some of the analytical difficulties that currently hamper drug monitoring in oncology but also underline the potential advantages arising from TDM.

The anthracycline doxorubicin has gained widespread use in the treatment of solid and haematological malignancies. Due to the induction of irreversible cardiotoxicity drug monitoring of doxorubicin has been repeatedly proposed in the past. As young children are at an

increased risk to develop long-term cardiac side effects and considering the otherwise long life expectancy of childhood cancer survivors, doxorubicin drug monitoring might be of particular benefit in this patient group. Monitoring of plasma concentrations in these most vulnerable patients, however, requires reducing the number and volume of blood samples to keep the patient's burden to a minimum.

Further, doxorubicin analysis is prone to errors arising from pre-analytical errors during blood sample collection and sample processing even if standardised sampling procedures are used.<sup>8,9</sup> The high sensitivity for pre-analytical errors especially affecting the measurement of peak concentrations and the need for very low blood volumes would make paediatric doxorubicin monitoring clearly benefit from more advanced analytical technologies.

Paclitaxel was firstly approved by the FDA in 1992 and, since then, it has been used to treat a plethora of solid tumours. Despite its ample and long-standing use, paclitaxel dosing is still not optimised. The currently applied "one dose fits all" appears not to be an appropriate approach since it does not take into account the significant inter- and intra-patient pharmacokinetic variability, leading to the risk of severe haematological and neuropathic toxicities.<sup>10,11</sup>

Moreover, paclitaxel is used in a wide range of doses (80-225 mg/m<sup>2</sup>) and it shows a disproportionate increase in systemic exposure with higher dosages. According to some studies, the duration of paclitaxel plasma concentrations above a threshold value correlates both with toxicity and anti-tumor activity. However, no consensus has still been reached on this value, with a proposed concentration of 0.05 µM.<sup>11</sup>

Nowadays, paclitaxel plasma concentrations are measured with standard time-consuming techniques, requiring sample preparation and specialised personnel.<sup>12</sup> In this scenario, an advanced technology allowing a real-time quantification of paclitaxel plasma concentrations may produce a dual benefit: to better clarify the threshold level and to promptly adjust the dose during the drug infusion. This would lead to overcome the difficulties that hinder the application of TDM in clinical practice, finally moving from the standard paclitaxel dosing to a more rational therapy personalisation.

Prospectively, refined analytical technologies could also be of substantial advantage for the safe and effective use of novel targeted therapies which show long half-lives and a high risk of accumulation.<sup>13</sup>

Thus, miniaturised, fast and easy to use bedside monitoring tests that allow obtaining reliable results from the smallest of sample volumes without error-prone sample processing would meet a so far unmet need. The gap in the technological development of adequate monitoring tests, meaning miniaturisation and delivery of the test to the point-of-care, is currently addressed by the DIACHEMO project that is funded by the EU Research and Innovation programme Horizon 2020 (Grant Agreement Number 633635).

The DIACHEMO project aims towards the development of a point-of-care analytical device that will provide a fast and reliable determination of chemotherapeutic drug concentrations, therefore, supporting the conduction of pharmacokinetic trials and the implementation of TDM approaches in daily clinical practice. To achieve this goal, three research institutions, two hospitals, two industrial partners and a professional EU

project management agency joined a European partnership.

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# DIACHEMO

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# Prostate cancer: The time is now

Over the last year, prostate cancer has grabbed the attention of the media, the nation and the UK government. We're gathering the tools for a screening programme – and we have a golden opportunity to push through our plans to stop prostate cancer killing men, explains Prostate Cancer UK Chief Executive, Angela Culhane

**P**rostate cancer research has been underfunded for too long. In the UK, one man dies from the disease every 45 minutes, and that's not simply because men don't know when they're at risk. Tests to diagnose the disease early are not accurate enough and the treatments currently available aren't always effective for each man's cancer.

In 2018, Prostate Cancer UK shone a spotlight on the shocking statistic that deaths from prostate cancer now outnumber those from breast cancer, making it the third biggest cancer killer in the UK for the first time.

The story dominated the news across media channels and, thanks to the public response, has kept prostate cancer on the agenda. Shortly after, TV personalities Stephen Fry and Bill Turnbull spoke about being diagnosed with aggressive prostate cancer, helping to raise awareness of the disease even further. This heightened awareness has made prostate cancer a problem that society can no longer ignore.

## **Long-term investment in research can turn the tide**

Prostate Cancer UK was formed as a charity not only to support men living with the disease but also to tackle the unjust lack of research into stopping prostate cancer being a killer. In 1998, the government spent just £47,000 on prostate cancer research. Back then, relatively little was known about the disease, but now our understanding is approaching the point where we can begin to see real change in how we diagnose and treat men.

With the heavy focus on prostate cancer in the media, Theresa May announced an additional £75 million

towards recruiting more men into prostate cancer clinical trials. This at last shows recognition of what a huge issue prostate cancer is and the focus needed to stop it from being a killer.

The difference that can be made through serious, long-term investment in research is clear when you look at the impact it has had on other diseases. By the late 1990s, there was already a screening programme for breast cancer, as well as genetic tests and precision medicine – all things that we are still working towards for prostate cancer.

Since that time, there has been only half as much spent on research into prostate cancer with the shortfall totalling hundreds of millions. As a result, the number of men dying from prostate cancer continues to rise.

If we want to reverse that trend for men, we need to invest heavily in research. One of the biggest and most important aspects of Prostate Cancer UK's research strategy is our work towards a screening programme.

## **Our plan for screening in the next five years**

We know that getting diagnosed early gives men the best chance possible, but the current tests are not reliable enough to be offered to all men regardless of their risk or symptoms. Too many men would have unnecessary biopsies and treatments, while lethal cancers continued to be missed. The harms would outweigh the benefits. But with better tests, we could have a system where all men over a certain age, would be invited for screening on a regular basis, similar to the way it works for breast and bowel cancer.

We know that there won't be a single perfect test. Instead, we expect it to be a series of tests that can





help to filter men out based on establishing their risk of having significant prostate cancer so that only those who really need it have to have a biopsy.

Until recently, the standard approach was to have a biopsy after a suspicious PSA test result, now thanks to our work many men have access to multiparametric MRI scans (mpMRI). This has already been a major step forward but isn't enough on its own.

We need new tests and improvements at each stage of diagnosis including a more specific test that could follow the PSA test to rule out some false positives (men who have a raised PSA but don't have cancer) before a mpMRI scan. This will most likely be an advanced type of blood test that looks for several markers of cancer, including proteins and genes that are linked to a high risk of cancer. It is difficult to find reliable markers that will work for everyone, which is why we're investing heavily in this area.

### **We can make the PSA test work harder**

We also want to improve our understanding of what a PSA result means for an individual man. We are currently funding research into a risk assessment tool, which will be able to take into account various different factors that influence a man's risk. This will help GPs to decide the best course of action for a man with a suspicious result.

Building on the progress that we've made so far, and other research evidence we want to collect over

coming years, our hope is to be in a position to call for a nationwide screening programme within five years. By then, we hope to be able to approach the National Screening Committee to present the evidence from our research and get a screening programme approved.

That is the scale of our ambition but if we're to stay on track to deliver that, we need to raise significant sums.

We're determined to make prostate cancer a disease future generations won't have to fear. But we can't do this alone. The government must follow through on its promise to prioritise early diagnosis of cancer and make the necessary resources and funding available to do so. If research breakthroughs are to have any impact on the man in the clinic, NHS England and equivalent bodies in other parts of the UK, must have the infrastructure, workforce, training and drive required to harness them. We must work together and focus efforts if we are to save more lives and build a better future for men. ■

### **Angela Culhane UK Chief Executive**

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# The role of heat shock proteins (HSPs) in cancer cells

Chester Medical School highlights the importance of heat shock proteins (HSPs) in cancer cells and how we might utilise them therapeutically

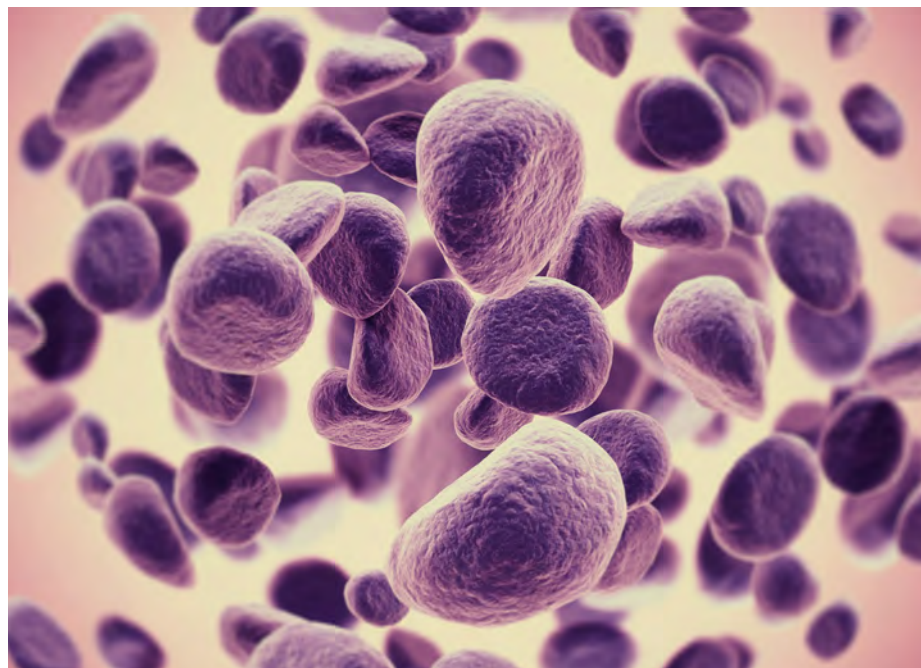
**H**eat shock proteins (HSPs) were originally identified as heat-inducible gene products that had a role in cell survival. We now know that many HSPs are not heat-inducible and that these highly conserved proteins have many roles in normal and stressed cells and are often referred to as molecular chaperones.

HSPs are involved in normal protein folding, re-folding partially denatured proteins, cell signalling and maintaining the conformation of receptor/signal transduction complexes. These are processes which are important in many diseases, such as Type 1 diabetes, Type 2 diabetes, Alzheimer's disease and cancer. As a result, there has been increasing interest in understanding cellular mechanisms so that we can see the potential for therapeutic interventions involving HSPs. The focus of this article will be the role of HSPs in cancer cells.

It has long been recognised that levels of HSPs tend to be elevated in cancer cells and as a result researchers have been interested in the role of HSPs in tumour development. Our work in Chester has helped elucidate some of the important mechanisms.

## Targeting Hsp27 and Hsp70

Two of the HSPs, Hsp27 and Hsp72, have been shown to be important to cell survival under a variety of stress situations – for example, elevated temperature or heavy metal exposure.



Both of these proteins bind to partially denatured proteins and allow refolding, they are, therefore, antiapoptotic. One of the features of cancer cells is that they are resistant to apoptosis, so there is obviously potential for targeting Hsp27 or Hsp72. By using specific inhibitors or siRNA we have shown that targeting either Hsp27 or Hsp72 does reduce transformed cell line viability.

However, when applied to primary cells the picture is less clear, because we see a high degree of variability in the response, although it is less pronounced in chronic lymphocytic leukaemia (CLL) than in colorectal cancer. The response in colorectal cancer primary cells suggests a high degree of specificity in the dependency of the cancer cell to HSP depletion.

## Targeting HSP90

Cancer research has been heavily influenced by the concept of 'The Hallmarks of Cancer' proposed by Hanahan and Weinberg in 2001 and then renewed in 2011. Hsp90 is a protein that has chaperone activity but also acts as a scaffold holding many receptor and signal transducer complexes in active conformation. As many signal transduction pathways are highly active in cancer cells, Hsp90 is a target that may impact on many, if not all, of the hallmarks of cancer.

There are a large number of Hsp90 inhibitors and these do indeed kill cancer cells, whether used in isolation or in combination with other chemotherapeutic agents. However, we again find that the inhibitors are





“It has long been recognised that levels of HSPs tend to be elevated in cancer cells and as a result researchers have been interested in the role of HSPs in tumour development. Our work in Chester has helped elucidate some of the important mechanisms.”

very efficient in transformed cells, but that there is greater variability in the response when using primary cells.

## Extracellular HSP

We and others have shown that Hsp70 and Hsp27 are both secreted from cells, including those in tumours. Further, we have been able to demonstrate that these HSPs stimulate an immune response. This may provide a novel approach to treating cancer by targeting the HSP to a tumour, such that it is then in a position to specifically activate natural killer cells and cytotoxic T cells to attack the cancer cells.

## Conclusion

When we examine the literature, we find that there is overwhelming evidence that HSPs have an important role in the initiation, development and maintenance of the tumour phenotype. Naturally, pharmaceutical com-

panies have put considerable effort into the development of Hsp90 inhibitors. Many of these inhibitors have entered clinical trials only to be withdrawn. Some for a lack of clinical activity, others because they seem to increase metastasis. This latter effect may be related to the fact that Hsp90 inhibitors tend to induce heat shock factor activity and, therefore, stimulate Hsp27 and Hsp72 production – making cancer harder to kill!

We would argue that the HSP inhibitors should be used with the target patient in mind and that, as highlighted in other studies, we need a personalised approach to the chemotherapeutic strategy. Most research at present focuses on the genetics of personalised therapy, but we suggest that a chaperone/HSP fingerprint of an individual tumour may also be worth exploring to allow more specific targeting of a tumour.

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# Prostate cancer: A riddle wrapped in a mystery inside an enigma

Professor Malcolm Mason, Cancer Research UK's Prostate Cancer Expert reveals why prostate cancer is a riddle wrapped in a mystery inside an enigma

Every year around 13,000 men in the UK die of prostate cancer. So it seems obvious that prevention and early detection ought to be the cornerstone of our strategy alongside new and better treatments for men who have this life-threatening disease. Unfortunately, it's not that simple. Prostate cancer – unlike other cancers – is a disease most men (especially those over 60) have, but it's usually an indolent condition that isn't life threatening.

There is huge public interest in PSA (a protein produced by cells of the prostate gland) as a 'simple blood test' for the early detection of prostate cancer. This has been fuelled by celebrities who have either been diagnosed and treated successfully following a PSA test, or who were found to have incurable and advanced prostate cancer having never had a PSA test. There is far less public interest in the hard evidence.

PSA undoubtedly detects more prostate cancer than we would otherwise diagnose. A recent study found that for men who have been diagnosed this way, the risk of dying from the disease over a 10-year period was only around 1%, even if they had no treatment and were put onto a surveillance programme.

What does this mean? PSA appears to be particularly good at finding men who have the usual, slow growing, non-life-threatening form of prostate cancer but is less good at finding men who have aggressive prostate cancer. Bluntly, most men, whose cancer is diagnosed after a PSA test, do not need treatment, although many of them may end up having it. Further proof of this comes from a study which showed that offering otherwise healthy men a single PSA test as a way to 'screen' for prostate cancer makes absolutely no difference to their chances of dying from the disease after a 10-year period.

Some advocate a more intensive use of PSA, rather than using a 'one-off' reading, but this is controversial as many men will still receive unnecessary treatment in the 'first sweep' of PSA testing. More promising avenues of research are other tests to complement PSA. Clinical trials have indicated that an MRI scan is a good way of picking out men whose PSA level is elevated, but who do not need a biopsy.

In the future, modern techniques in molecular genetics and molecular biochemistry may be able to identify men at higher risk of developing life-threatening prostate cancer. It will be some years before we know whether combining these molecular tests with an MRI plus PSA can provide an answer, but it is an exciting prospect.

Another vital aspect we need to improve is identifying men at high risk of developing prostate cancer.

We know that Afro-Caribbean men, men with an extremely strong family history of the disease (especially families with multiple close relatives diagnosed at a very early age), and men who carry a mutation in the breast cancer gene BRCA-2, are at increased risk. But there are other men at high risk in the population, and to date we don't know who they are. We must research ways to find them.

At the other end of the spectrum are men with disease that we know to be aggressive. Clinical trials have shown that for many of these men, local treatment with radiotherapy (and presumably surgery) prevents death from prostate cancer.

For men with advanced disease, Cancer Research UK's STAMPEDE trial showed that early use of chemotherapy, or one of the newer anti-hormonal agents, plus stan-



dard therapy, prolongs survival even if it doesn't cure the disease. These are now the gold standards of care.

But waiting in the wings are generations of newer treatments which target specific molecular defects in prostate cancer cells.

We now know that what we call 'prostate cancer' is a spectrum of diseases which vary immensely in what goes wrong at the genetic or molecular level. Some of these new biological treatments target subpopulations of men whose cancer has a specific defect. For example, the drugs known as PARP inhibitors might target cancers which have a defect in their ability to repair DNA. Our understanding of these new concepts is in its infancy. Ongoing research will expand our knowledge and maybe even lead to new treatments that we can't yet imagine.

Our hope is that through these two strands of research – pin pointing and diagnosing men at risk of aggressive cancer and developing new treatments for men with specific molecular subtypes of advanced cancer – we can save lives. Both these strands go hand in hand and should lead us to the same group of men – those who, today, die of prostate cancer despite our best efforts. ■

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# TGF- $\beta$ signalling – Tumor biology in prostate cancer

Identifying the molecular signalling pathways leading to advanced prostate cancer to improve therapy and diagnosis

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Prostate cancer is the most common tumor in men in the Western society and the incidence is expected to increase. However, we still lack good molecular tools to identify aggressive prostate cancer.

Our aim is to identify the molecular signalling pathways leading to advanced prostate cancer. This knowledge will be used to design novel therapeutic strategies and improved molecular diagnostic tools.

## **TGF $\beta$ signal transduction**

Our research is focused on TGF $\beta$  signal transduction, tumour biology and molecular pathology, particularly in prostate cancer. TGF $\beta$  plays an important role for regulation of migration and invasion in several kinds of cancer cells, including prostate cancer cells.

In aggressive prostate cancer there is a correlation between the amount of secreted TGF $\beta$  and poor prognosis with development of metastases. We have found that the ubiquitin-ligase TRAF6 is a crucial co-regulator of TGF $\beta$ -induced non-canonical and oncogenic responses, as it associates with the TGF $\beta$  type I receptor. TRAF6 promotes also expression and activation of proteolytic enzymes, such as TACE and presenilin1, which cleaves the TGF $\beta$  type I receptor to liberate its intracellular domain (ICD). The generated ICD translocate to the nucleus in

an unknown manner, where it contributes to gene transcription of pro-invasive and metastatic genes. We focus our research on exploring how TGF $\beta$  regulates invasive and metastatic behaviour of prostate cancer cells. We have access to unique collections of biobanked material at Biobanken Norr in collaboration with researchers here in Umeå.

## **Collaboration**

We collaborate with national and local cancer researchers in the field of prostate cancer and renal carcinoma.

We collaborate with [SciLifeLab Drug Discovery Platform](#) in order to design novel and more specific cancer drugs.



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“Our aim is to identify the molecular signalling pathways leading to advanced prostate cancer. This knowledge will be used to design novel therapeutic strategies and improved molecular diagnostic tools.”



# A new front against Ebola: Extensive support for preparedness activities in Africa

In an interview with Open Access Government, Dr Ibrahim Socé Fall, WHO Health Emergencies Director for the African Region tells us about the excellent work that WHO Regional Office for Africa is doing around Ebola in the Democratic Republic of Congo (DRC), near the border with Uganda

**D**octor Ibrahima Socé Fall is the Regional Emergencies Director leading the newly established WHO Health Emergencies programme (WHE) at the WHO Regional Office for Africa. His background includes his work as a WHO Representative in Mali during the political and humanitarian crisis when WHO needed strong leadership and expertise to deal with complex emergencies. Dr Fall was trained as a military physician and has over 25 years' experience in medical practice and public health.

In an interview with Open Access Government, Dr Fall details the excellent work that WHO Regional Office for Africa is doing around Ebola in the Democratic Republic of Congo (DRC), near the border with Uganda. This includes the work communication experts from the Ministry of Health, WHO and other partners are doing in terms of providing all the required information on the appropriate preventive measures to be observed in respect of Ebola. We also find out about the challenges around managing an outbreak of Ebola and why is it important to engage with key communities and raise awareness of symptoms, as well as what to do if a case is suspected.

## **What is WHO doing to scale-up a new front against Ebola in the Democratic Republic of Congo (DRC), near the border with Uganda?**

WHO currently has about 300 specialists deployed to DRC to support the response. In Goma, the scale-up of the response team across all pillars is underway with WHO and partner staff.

Activities in North Kivu include: risk communications/ community engagement, contact tracing, safe and dignified burials, case management (patient care),

provision of therapeutics, vaccinations, the survivor programme, infection prevention and control (IPC), support for laboratories, and supporting preparedness and readiness.

In DRC, preparedness activities continue in all border districts. Fifty key points of entry in affected areas have strengthened capacity to rapidly detect and respond to potential Ebola cases. Close to six million travellers have been screened at these points of entry since the beginning of screening.

Outside of DRC, WHO's regional preparedness plan prioritises neighbouring countries based on proximity to North Kivu:

- **Priority 1:** Rwanda, Uganda, South Sudan, and Burundi;
- **Priority 2:** Angola, Congo, Central African Republic, Tanzania, and Zambia.

WHO has deployed Preparedness Support Teams to these countries.

In Uganda, WHO has provided extensive support for preparedness activities. Uganda began vaccinating health and frontline workers in high-risk areas on 7th November. As of 30 November, more than 1,500 health and frontline workers in 51 health facilities have been vaccinated. It is expected that 2,100 doses of vaccine will be administered to health workers in the country. If no Ebola case is confirmed in Uganda, these vaccinations should have been completed by late December 2018. WHO has provided the technical support and guidance to the Ugandan Ministry of Health in the areas of protocol development, development of



standard operating procedures (SOPs), implementation planning, training of vaccination teams and financial support for the vaccination exercise, including the vaccine.

WHO has also supported Uganda through the hiring and deployment of technical staff in a surge capacity; through technical advice and support to all pillars of preparedness; and resource mobilisation.

WHO has set up Ebola treatment units (ETUs) in all high-risk districts; supported collection, transportation and testing of blood samples from alert cases; trained frontline health workers on surveillance and infection prevention and control (IPC); and supplied materials used at the points of entry for screening.

Other countries are also stepping up preparedness activities.

South Sudan has just completed the construction of a 24-bed ETU in Juba to isolate and treat any Ebola patients, should the need arise. WHO has deployed 15 experts to support Ebola preparedness activities in South Sudan.

In Rwanda, preparedness efforts have focused on increased community engagement, as well as support for strengthening surveillance, laboratory, epidemiol-

ogy, infection prevention and control and patient care capacities. Health screening is being conducted at all high-risk border crossing points. And a health facility in Rubavu in Rugerero district (near to Goma in DRC) has been repurposed as an Ebola treatment centre.

Likewise, Uganda remains on high alert and is implementing a series of activities to ensure preparedness. These activities include border screening, community-based and health facility surveillance, collection and testing of blood samples from alert cases, and capacity building for infection, prevention and control. Other efforts are focused on clinical management, psycho-

social care, safe and dignified burials, risk communication and community engagement, and cross-border surveillance.

### **Tell us about the work communication experts from the Ministry of Health, WHO and other partners are doing in terms of providing all the required information on the appropriate preventive measures to be observed in respect of Ebola.**

Risk communications and community engagement experts are working across all areas of the response. Experienced staff are embedded in contact tracing teams, in safe and dignified burial teams, in patient care teams, and in infection prevention and control work. These experts are also actively involving formal community leaders, religious leaders and informal influential community groups, and private sector workers (including those in the transport sector, pharmacists, and formal and informal health care workers, including traditional healers).

### **In this vein, what are the key issues when it comes to surveillance and vaccination?**

Most communities support the response. The Ministry of Health, WHO and partners continue to work closely with communities and are able to provide vaccines to contacts and treatment to those who are sick. However, faced with rumours and misinformation,





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some families have chosen to care for sick relatives at home; some patients leave health care centres to find alternatives or actively avoid follow up. This increases the risk to themselves, their relatives and health workers, and contributes to the spread of the outbreak.

## **How are cases of Ebola controlled? What are the challenges around managing an outbreak of Ebola?**

Managing the current Ebola outbreak in the difficult and dangerous operating environment of Kivu is particularly challenging. There have been numerous security incidents, particularly in Beni and Butembo. The majority of these have targeted UN peacekeepers but incidents have at times impeded the response or temporarily shut it down altogether. There have also been incidents of community resistance. Community violence has at times also impeded the ability of burial teams to conduct safe and dignified burials.

One of the other challenges in this outbreak is the number of health workers infected. Health workers are particularly vulnerable to being infected by Ebola as they are one of the first points of contact. They can also amplify spread as they have contact with many patients. In order to protect themselves and others, health workers need training, supplies and facilities that permit them to practice infection prevention and control. WHO and partners such as the International Rescue Committee are working with health centres in the Ebola-affected areas to provide training and supplies (181 health centres decontaminated, and over 400 health workers trained). It is an uphill battle considering the sheer number of centres and the lack of adequate infrastructure (often no electricity and no piped water). Over 8,700 frontline and health workers have also been vaccinated, which is another line of defence for them.

## **Finally, why is it important to engage with key communities and raise awareness regarding the symptoms of Ebola and how to prevent it, as well as what to do if a case is suspected?**

Community engagement is an essential part of any disease outbreak response. In the context of Ebola, it is particularly critical as the severity of symptoms and the rapid deterioration of health can lead to fear and misunderstanding of the cause of illness and death.

Some of the recommendations to stop the spread of Ebola may interfere with local beliefs and practices and cause disruption to the lives of local communities.

The control of Ebola is resource intensive and requires adequate early detection of people suspected of being infected with Ebola, rapid laboratory testing, treatment of patients who are confirmed of Ebola infection and follow up of their contacts for at least 21 days so that those who develop signs and symptoms of the illness are quickly identified and provided with early treatment. The funerals of Ebola victims should be performed in a safe and dignified manner, with respect for grieving families.

Early communication of Ebola risk and engagement with local communities and health workers is pivotal to the prevention and control of an Ebola outbreak. To communicate effectively with communities, response teams must approach community leaders and members in a way that seeks first to understand their perspectives, solicits their inputs, shares information, and engages them in the response to the outbreak.

In addition, information must be shared in a manner that allows individuals and communities to learn (receive information and ask questions) and to make informed decisions about how to protect themselves, their families, and communities. Community leaders and members must be a part of, and have an influence on, response efforts. Effective engagement involves on-going interactions that include adjusting risk communication strategies in response to community signals. ■

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# The role of anthropology and technology in the Ebola vaccine response

Heidi Larson, Director of the Vaccine Confidence Project™ and Professor of Anthropology, Risk and Decision Science and researcher Sara Dada at LSHTM, discuss the advancements of Ebola vaccine response

Controlling disease outbreaks has been revolutionized by advances in technology and biomedicine. Since the eradication of smallpox in the 1980s, the role of technological advances in vaccine development, surveillance and treatment has been unmistakably valuable, but often missing consideration of the perspectives which social science can contribute. Anthropologists have been actively helping to build bridges between social science and public health approaches to disease outbreak response/preparedness – most recently in the case of Ebola.

Throughout the Ebola vaccine trials in Sierra Leone, collaboration was essential between anthropologists, communities and managing the clinical vaccine trials. The purpose of the EBODAC (Ebola Vaccine Deployment, Acceptance and Compliance) Consortium – a partnership between the London School of Hygiene & Tropical Medicine, Janssen Pharmaceuticals, World Vision and the Grameen Foundation – was to develop community engagement strategies to manage rumours and build trust, and particularly to ensure vaccine compliance. In addition, an important objective was to prepare for future vaccine deployment through strengthening communities and health systems to be better prepared and able to respond to future outbreaks.

The scale of the 2014 – 2016 West

Africa Ebola outbreak was both unprecedented and devastating. In attempting to stem the outbreak, the necessity of considering sociocultural and political settings in developing effective and efficient response mechanisms soon became clear. Initial communications around Ebola in the early months of the outbreak concentrated on correcting misperceptions and misinformation about the disease more than engaging local populations in a reciprocal dialogue.

For example, many sensitisation messages focussed on general knowledge of Ebola symptoms or the role of 'traditional practices' such as burial rituals in spreading the disease. Criticism of this strategy pointed to the lack of practical information that communities could act on to respond to their concerns – such as what to do with an exposed, infectious body or how to manage a family in quarantine, especially if help was delayed. Eventually, considering the sociocultural contexts and the needs of the community proved to be an important factor in an effective Ebola response.

Despite this recognised need, there was a lack of standardised guidance around using community engagement in outbreak settings, including around clinical trials and other research. Lessons learned from the IMI-funded EBODAC project can fill these gaps by sharing expertise that could be relevant in other settings, such as in the

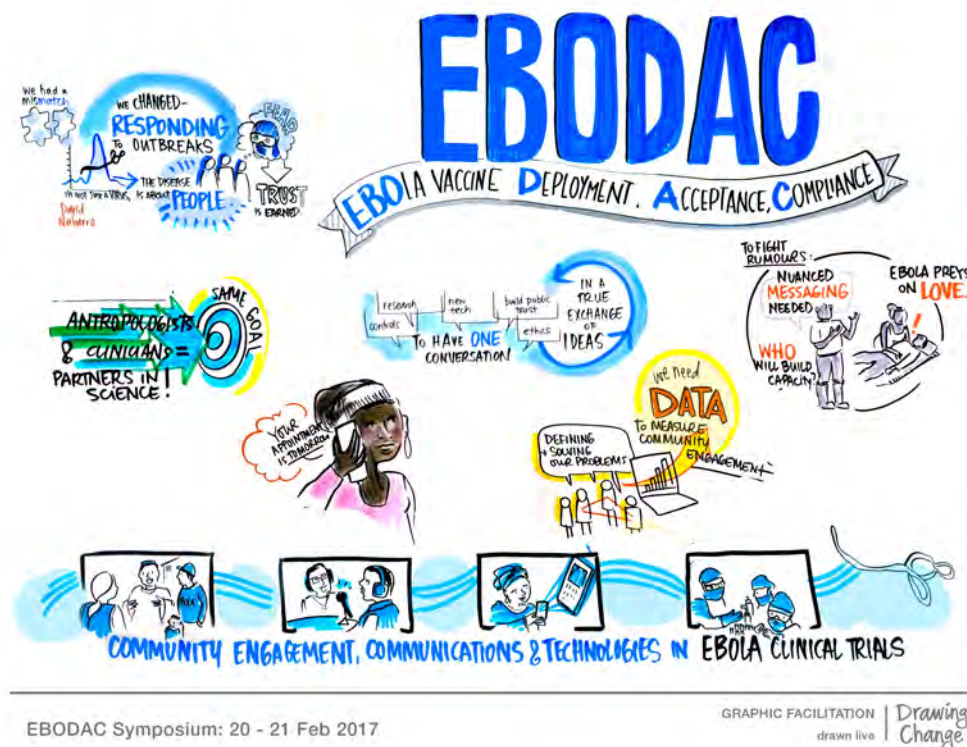
most recent Ebola outbreak in the Democratic Republic of the Congo.

The EBODAC project aims to build awareness and trust in the communities as well as provide a mechanism to quickly respond to concerns or rumours. Reciprocal communication strategies between health personnel and multiple levels of the community proved key. Respecting traditional power structures and consulting both local leaders and community members on their concerns, as well as ideas, regarding participant recruitment and the trial process, increased the acceptability of the trial in the community.

In one example, through speaking with local community members, researchers found that the stigma surrounding Ebola would be a barrier to the implementation of formal identification of trial participants in these communities. Researchers needed to identify potential trial volunteers in a confidential but reliable way. This led to the development of an identification kit that combined iris scanning and fingerprinting biometrics to confidentially and correctly identify volunteers during subsequent visits, without the use of a print ID card.

In another innovation, EBODAC uses communication technology to strengthen response and preparedness for Ebola outbreaks through a mobile training support system (MOTS). This mobile tool provides community





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health workers in Sierra Leone with interactive training materials in local languages that can be accessed from their regular mobile phones at no cost. These modules provide information relating to the Ebola vaccine and disease surveillance practices to local community members to prepare them for future vaccine deployment. By considering the context of the setting – such as language, accessibility and resource availability – anthropological methods have informed the pilot and rollout of MOTS to make it a useful tool in those communities.

The work of EBODAC has brought together not only the different fields of anthropology and medical and communication technologies but also different sectors in a public-private partnership. In outbreak or disease-preparedness settings, private-public cooperation, such as EBODAC, can be a valuable support to in-country operations and capacity building.

Looking forward, EBODAC's newly developed gap analysis assessment tool will help governments assess their level of preparedness in responding

to Ebola outbreaks or deploying the vaccine. These tools and the interdisciplinary-approach embraced by EBODAC could provide valuable insight into settings such as the DRC where outbreak response is highly influenced by socioeconomic and political factors such as ongoing conflict in the region. The work led by EBODAC and the harmony of technology and anthropology collaboration could become a model for future disease preparedness and outbreak response programmes.

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# Tackling HIV in the African Region: Improving the health and well-being of people

The efforts of the WHO Regional Office for Africa in tackling HIV in the African Region are detailed here, which is part of the organisation's wider aim to improve the health and well-being of people

**W**HO Regional Office for Africa serves the WHO African Region, which is made up of 47 Member States with the Regional Office in Brazzaville, Republic of Congo. It is one of the World Health Organization's (WHO) six regional offices around the globe. As the lead health authority within the United Nations (UN) system, they work with the Member States and development partners to improve the health and well-being of people.

Their main focus areas include health sector development, combatting diseases – infectious diseases, such as HIV and tuberculosis (TB), plus non-infectious diseases like diabetes, cancer and heart disease. In addition, WHO Regional Office for Africa prepares for and rapidly respond to emergencies and disasters, plus they assist mothers and children to survive and thrive so they can enjoy reaching a healthy old age. In addition, WHO staff have a shared belief that all people are entitled to good quality affordable health care without falling into poverty. <sup>(1)</sup>

## **HIV in the African Region: “Know your status”**

On 1st December 2018, the world community marked the 30th anniversary of World AIDS Day. 2018's theme is “Know your status”. In the view of Regional Office for Africa, HIV testing empowers people to make choices about HIV prevention and exactly how to protect themselves and their loved ones.

1st December 2018 was also a chance to celebrate the 30th anniversary of World AIDS Day – a global health campaign initiated by WHO back in 1988. The WHO Regional Office for Africa marked that milestone with stories of people who have been living with HIV for a very long time. One comment came from an activist in Congo, Thierry Maba, who said: “We must eliminate

discrimination so that everyone can access HIV services.” Another came from a musician in Uganda, Moses Nsubuga who said: “It is very important to know your status. There is life after testing.” Many thought they would never live to see today.

WHO's Regional Director for Africa, Dr Matshidiso Moeti gave a message on World AIDS Day 2018, where she said that the only way to determine a person's HIV status is for them to have a test in order for them to know their status. She also offered her thoughts on HIV testing, life-saving antiretroviral therapy and work taking place to accelerate the expansion of HIV testing programmes.

“HIV testing is essential in expanding treatment and ensuring that all people living with HIV can lead healthy and productive lives. It is also crucial in ensuring that 90% of people living with HIV know their HIV status; 90% of people diagnosed with HIV receive antiretroviral therapy; and 90% of people living with HIV, and who are on treatment, achieve viral load suppression. HIV testing empowers people to make choices about HIV prevention specifically how to protect themselves and their loved ones.

“Significant progress has been made in the AIDS response since 1988, and today four in five (20.8 million) people living with HIV in the African Region know their status. In addition, more than three in five (15.3 million) people are accessing life-saving antiretroviral therapy. There is a more than 30% reduction in AIDS related deaths since 2010 and people living with HIV are leading longer, healthier lives thanks to the sustained access to antiretroviral therapy.

“However, this progress is not uniform in our Region. For example, in West and Central Africa, only one in



*A doctor consults with mother and children about HIV/AIDS at Pepo La Tumaini Jangwani, HIV/AIDS Community Rehabilitation Program*

Image: © Joe Schim | Dreamstime.com

two (2.9 million) people living with HIV know their status. That is why WHO, partners and Member States in the sub-region are working together to accelerate the expansion of HIV testing programmes in order to reach people living with HIV who do not know their status and ensuring that they are linked to quality and prevention services.”

Dr Matshidiso Moeti then explained that many, including adult men and young people, are being left behind and others still only get tested after becoming ill. She added that stigma and discrimination still deter people from taking a test and said that access to confidential HIV testing is still a cause of concern. The ones who are left behind are those most affected by HIV, including sex workers, people who use drugs and men who have sex with men and prisoners. In her message, she went on to detail her thoughts on WHO’s plans for expanding HIV testing, prevention and treatment in the future. This note of optimism is a good place for this article to conclude.

“As part of the new 5-year strategy for WHO, we are working with Member States in the African Region to strengthen their health systems and help them progress towards universal health coverage, so that all people have access to the services they need, without facing financial hardship. Universal health coverage offers an opportunity to expand HIV testing, preven-

tion and treatment that is integrated with other programmes and services such as TB, and sexual and reproductive health.

“I call on countries to use the new HIV testing strategies and to choose a strategic mix of service delivery models to achieve universal and equitable access to HIV testing and counselling. We need to expand community-based options and innovations to reach beyond health facilities. We also have to build strong linkages to guarantee HIV prevention, care and treatment services after testing. In all this we need the political will; we need the investment from governments, partners and private sectors, and most of all, we need the communities to promote demand for HIV testing services.” <sup>(2)</sup> ■

*For more information on why the HIV epidemic is not over, visit: <https://www.who.int/hiv-aids/latest-news-and-events/why-the-hiv-epidemic-is-not-over>*

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# Emerging and vector-borne disease research and training

Dr Leonard E.G. Mboera discusses the importance of studying emerging and vector-borne diseases at The Southern African Centre for Infectious Disease Surveillance, including challenges to address in this vein

Statistics indicate that infectious diseases are the second cause of illness and death in the world and the first in developing countries. They are responsible for about 15 million deaths each year.

In addition to the high endemicity of infectious diseases such as HIV/AIDS, tuberculosis (TB) and Malaria, various new pathogens causing infections have been identified, while several diseases supposedly under control, are re-emerging and causing multiple epidemics in Sub-Saharan Africa. Among the emerging and re-emerging diseases, those transmitted by insects, especially, those spread by mosquitoes are increasingly becoming a threat.

The Southern African Centre for Infectious Disease Surveillance (SACIDS) is concerned by the burden of emerging and vector-borne diseases (EVBD) in Sub-Saharan Africa. EVBDs represent a great proportion of the neglected tropical diseases, which disproportionately affect the poorest and most disadvantaged populations. In recent years, the increase in speed and volume of global travel and expansion of vectors and their adaptability has placed many more people at risk of contracting EVBDs. The major focus of SACIDS community of practice (CoP) on emerging and vector-borne diseases is on viral haemorrhagic fevers (VHF) and mosquito-borne viral diseases. These include Ebola virus disease

(EVD), Marburg, yellow fever, Rift Valley fever (RVF), dengue, Zika and chikungunya. SACIDS realises the need to establish strategic research and training programmes in EVBDs.

## CoP Composition

The CoP-EVBD is co-lead by Dr Leonard Mboera (SACIDS) and Prof Janusz Paweska (National Institute for Communicable Diseases, South Africa). Scientists working with the CoP are Prof Gerald Misinzo (Sokoine University of Agriculture, SUA) and Dr Calvin Sindato (National Institute for Medical Research). Nationally, the CoP works with scientists from Ifakara Health Institute, National Institute for Medical Research and Kilimanjaro Christian Medical University College.

Regionally, the CoP works with the University of Zambia, Uganda Virus Research Institute and National Institute for Biomedical Research, Democratic Republic of Congo. Internationally, we work with Royal Veterinary College of London, United Kingdom, University of Manchester, UK, Institute of Endemic Disease, Sudan, Korea National Institute of Health and Vrije Universiteit Brussel, Belgium.

## How we operate

SACIDS operates as a Virtual Centre linking academic and research institutions in Southern Africa, headquartered at the Sokoine University of Agriculture. Research and training is

carried out by multi-disciplinary teams through theme-based communities of practices. One such theme is EVBDs. Each SACIDS associated project has a designated team with a Principal Investigator and co-investigators.

## What we aim to achieve

The CoP aims at developing the regional capability for detection and response to emerging and vector-borne diseases. The goal is to contribute towards the reduction in morbidity and mortality due to EVBDs. The overall objective is to improve the understanding and prevention/control strategies of EVBD and increase productivity in Sub-Saharan Africa.

## The CoP working hypothesis

The CoP working hypothesis is that the variable involved in the development of new infectious disease outbreaks and re-emerging of the old ones are influenced by complex interactions between the host, the pathogen, and the natural and social environment. Thus the continuous interactions between human, animal and environments facilitate the onset, spread and maintenance of infectious emerging and vector-borne diseases in Africa.

## Research approach

Although there is evidence that EVBDs are rising in the region, the magnitude of the burden is not known with cer-

tainty and the capacity of the health systems to address them is weak. The CoP aims at adding value to the existing surveillance systems for human and animal diseases in developing capability in the disease detection and early warning systems.

The CoP identified strategic approaches include the need to strengthen:

- (i) Regional capacities for early detection, identification and response to emerging and vector-borne diseases
- (ii) Regional capacities in predictive and computational modelling skills for epidemic-prone diseases;
- (iii) Systems for data collection, analysis, interpretation and information dissemination for EVBDs and;
- (iv) The utilisation of routine disease surveillance, climate and research data to improve the community, national and regional capacity to timely respond to EVBD epidemics.

## Training and research strategies

To achieve its objectives, SACIDS realises the need to establish strategic post-graduate programmes on infectious diseases in humans and animals. This is done through the recently established Africa Centres of Excellence at the Sokoine University of Agriculture (Tanzania) and the University of Zambia (Zambia). Currently, one post-doctoral fellow, three PhD and one MPhil students work with the CoP. The PhD research subjects include the development of disease prediction models for mosquito-borne arboviral

diseases in the Democratic Republic of Congo and development of novel diagnostic tools for detection of VHF, dengue and chikungunya viruses. The CoP Post-doc fellow is working on Priority Zoonoses Outbreaks in Africa under a new initiative supported by the European and Developing Countries Clinical Trial Partnership titled "The Pan-African Network for Rapid Research, Response, Relief and Preparedness for Infectious Disease Epidemics".

## Stakeholder's engagement

Early in 2018, the CoP carried out a gap analysis of the capability for emerging and vector-borne diseases in Tanzania. The analysis realised that the country has limited capacity in mosquito-borne viral disease and that, the country is least prepared to deal with VHF outbreaks due to the limited health system capacity.

Recently, CoP scientists have developed prediction models for Rift Valley fever (RVF) and dengue. The CoP has taken initiatives to develop and conduct training courses on novel serological and molecular diagnostic techniques and high-level next-generation sequencing. Our future focus is to enhance the molecular biology skill sets of researchers to empower them with analytical skills, including bioinformatics. During June 2018, SACIDS initiated discussion with Tanzania's government to Establish national arbovirus infection sentinel surveillance sites to capture events of arbovirus infections including dengue and chikungunya at the community level. Preparation to establish the sites is underway.

## Beneficiaries of the CoP

While our ultimate beneficiaries are the communities in Sub-Saharan Africa, the immediate beneficiaries are the scientists and institutions in the partner countries. Other beneficiaries include practitioners, programme managers and decision makers who are directly involved in the implementation of SACIDS programmes.



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# Infectious disease: A worldwide research challenge

Prof Colin J Suckling OBE DSc FRSE, Research Professor of Chemistry at the University of Strathclyde imparts his expertise on the worldwide research challenge of infectious disease and argues that this is both diverse and everywhere

If it were just a few bacteria infecting a few unlucky people in a developed country with a good health care system, would there be any political interest? If the cattle in East and West Africa are suffering from debilitating parasitic disease that threatens their lives and the livelihoods of their farmers, would there be any media coverage? If villagers in central India have no cure for the visceral diseases that affect them, would there be a response? Probably not.

On the other hand, when hospital wards are closed because of *Escherichia coli* or *Clostridium difficile* infections, or when tuberculosis (TB) starts to reappear in urban communities, or when travellers return from the tropics with malaria the attention of politicians, the media, and the pharmaceutical industry (to some extent at least) is engaged and the rhetoric of antimicrobial resistance – ('the antibiotic apocalypse', for example) is launched. Reports urging action abound, most recently from [the OECD](#).

Our response to this worldwide challenge in our research at the University of Strathclyde took a big risk, one that would have been inappropriate in an early stage industrial project. We chose to investigate a class of compounds that target DNA, the molecule that bears all of the basic information necessary for life that is present in all living cells, including our own. By targeting

DNA, it would be expected that our compounds would be able to shut down some essential biological operations of the cells and, thereby, lead to their death.

Moreover, because more than one essential pathway is likely to be affected, our compounds would be expected to be less susceptible to the emergence of resistance than a drug discovered according to the conventional single target-single drug paradigm of big pharma. With this strategy, our compounds, the minor groove binders or S-MGBs as we call them, should be minimally susceptible to the development of resistance, ideal for the AMR era, and moreover, potentially effective against infectious organisms worldwide.

There remains, however, a big problem and challenge. If the toxic effect of the S-MGB takes place in the cells of the infectious agent, bacterium, fungus, or parasite, all is well; but if the S-MGB harms the patient, human or animal, the compound is useless as an antimicrobial because of its patient toxicity. The challenge, which is the big risk from the industrial point of view, is to obtain sufficient selectivity between patient and infectious organism to provide a cure.

In this sort of circumstance, it is appropriate for academic laboratories to play a pioneering role. We have

made use of imaginative heterocyclic chemistry to obtain a wide range of novel S-MGBs with different property profiles, thereby, allowing us to select really promising compounds. So how well have we done?

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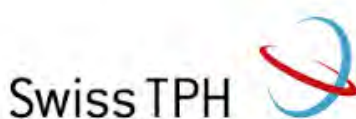
**"Our response to this worldwide challenge in our research at the University of Strathclyde took a big risk, one that would have been inappropriate in an early stage industrial project."**

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Let's take a few criteria, increasing in stringency leading towards a marketable drug. In the AMR era, the first test is whether a compound like one of our S-MGBs is active in the laboratory against infectious organisms that are resistant to currently used drugs. The second test is whether an MGB is non-toxic to mammalian host cells in the laboratory so that there is a window of safety between killing the infectious organism and harming the patient. The third test is whether the compound is sufficiently potent to be clinically significant.

Happily, we now have S-MGBs that meet these criteria for infections caused by many bacteria, including so-called superbugs and bacteria that cause TB, and fungi and by parasites, including the malaria parasite but especially those that cause sleeping sickness and related diseases (trypanosomes). These results have come





### Current and previous partners and collaborators in the international S-MGB project

Mike Barrett (University of Glasgow), Liam Morrison (Roslin Institute, University of Edinburgh), Kirsten Gillingwater (Swiss Tropical Public Health Institute), Vicky Avery (Griffith University), Reto Guler (University of Cape Town) and Mike Bromley (University of Manchester).

from collaborations with scientists in Europe, Australia, India, and South America.

Moving on in stringency, the next test is whether an S-MGB can cure the infection in a mouse or other small rodent; this is what is referred to as a proof-of-concept test because it shows whether or not the potential drug can do what we want it to and treat the infection without harming the host animal. In academic projects, this is usually as far as we take the experimental programme. Again happily, we have proof-of-concept results for

infections caused by Gram-positive infections, mycobacterial infections (TB), and parasitic infections caused by trypanosomes.

From this stage, we can move to a candidate drug, although usually not without the support of an industrial partner. Based upon its profile, many chemical and biological properties, compounds can be selected for full-scale development. This has been done so far for one of our S-MGBs, a compound for the treatment of *Clostridium difficile* infections. In the hands of our partner company, MGB

Biopharma, it has now reached Phase 2 clinical trials results from which should be available in 2019.

During the past five years, there has been a major investment from public funds in research concerning all aspects of antimicrobial resistance. For economically important diseases that affect the human population, such as malaria and TB, there are many compounds in development supported by big pharma, some in the latter stages of clinical trials.

For other diseases and for animal use, the lower economic incentive for big pharma means that things are lagging, relatively speaking. The development of one antiparasitic drug for animal use was halted because of the economically unacceptably high cost of development. Time alone will tell whether the efforts of the past 10 years have been sufficient to protect human and animal populations against the ravages of infectious disease or whether in 20 years' time the antibiotic apocalypse will not have been avoided but simply delayed.



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# How inequality leads to poor asthma outcomes

Dr Samantha Walker, Director of Research and Policy details how inequality in the UK leads to poor asthma outcomes

**A**n estimated 5.4 million adults and children in the UK live with asthma, a life-threatening respiratory condition, and three people die from an asthma attack every day. What is particularly concerning to us at Asthma UK is that the very place where people live appears to determine whether they get asthma, are hospitalised or even die from an asthma attack.

Asthma UK's latest report [On The Edge: How inequality affects people with asthma](#) highlights how asthma outcomes are linked to deprivation. An individual living in North Manchester, which has the highest hospital admission rates in England and is the second most deprived area in the country, is four times more likely to be hospitalised for their condition compared to someone in Rushcliffe in Nottinghamshire which has lowest hospital admission rates and is one of the wealthiest areas in the country.

The findings are deeply concerning. Children living in deprived areas are also more likely to have poorer asthma outcomes. Exposure to second-hand smoke can worsen asthma symptoms and people on low incomes are more likely to smoke. Living in a more polluted area and breathing harmful toxins can also exacerbate asthma while mould, which is more likely in poor quality housing, can also be a trigger.

Many people are also not getting basic asthma care. Clinical guidelines suggest everyone with asthma should get basic care which includes getting a written asthma action plan, having their inhaler technique checked and having a yearly review with a GP or asthma nurse. But we know from Asthma UK's research <sup>(1)</sup> that there is huge variation across the UK. Manchester has one of the highest rates of hospital

admissions and poverty, yet 65% of people the North West of England do not receive basic care.

It cannot be right that people living with asthma are more likely to have worse outcomes because of where they live. This is why Asthma UK is calling on NHS healthcare commissioners and the government to tackle health inequalities. Receiving good basic care is essential in helping people to manage their asthma and could save the NHS money in the long run if it reduces people's need to get hospital treatment. It is essential that primary care services are properly resourced so patients can get appointments to see their GP or asthma nurse, and that healthcare professionals feel equipped to provide their patients with basic asthma care.

The conditions of where and how people live also need to change. We wouldn't ask someone to drink dirty water, so it cannot be right that we ask people to breathe dirty air. We are calling on the government to combat air pollution by introducing a Clean Air Act. Improving social housing to prevent people with asthma living in damp, mouldy homes is also essential to improve asthma outcomes.

One of the hurdles in ensuring that people with asthma stay well, especially those with low health literacy in deprived areas, is that many don't understand how to manage their asthma which can be complicated in terms of different inhalers, different doses etc. For example, around 30-70% of people with asthma <sup>(2)</sup> don't take their preventer medicine as prescribed – even though it is the most effective way of them staying well. This is because it builds up protection in someone's airways over time, so if they come into contact with a trigger they're less likely to have an asthma attack.



Technological innovations could offer a solution. For example, smart inhalers, which are not yet available on the NHS, use Bluetooth® technology to track how people use their inhalers in real time. This data could be shared with their GP or asthma nurse who would be able to detect any trends or assess how well they are managing their asthma – and adjust their care accordingly. Sharing data between primary and secondary care services can also lead to more holistic care. For example, if a patient presents at A&E due to an asthma attack, their GP can be easily notified so they can offer them the support they need to avoid having another asthma attack.

It is inexcusable that where someone lives could affect their asthma outcomes. By tackling insufficient basic care, pollution and housing and enabling technology to play a part in revolutionising healthcare, we can make this a thing of the past.

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# Health research: Why can asthma still not be cured?

Michael Roth, Research Group Leader at the University Hospital Basel explains what asthma is, its health impact globally and charts the research landscape in the field, as well as pondering why asthma still cannot be cured

Asthma is defined as a chronic inflammatory disease of the upper airways, which limits breathing and, therefore, impacting the quality of life of millions of people worldwide. The economic burden of asthma to the health systems and our society is largely underestimated. Asthma is frequently overlooked or wrongly diagnosed, as it was reported in the 2016 EU Symposium on Allergic Diseases. However, it would be wrong to define asthma as an allergic disease, approximately 45% of all asthma patients cannot be linked to allergies. This raises the question “What is asthma?”

Asthma can start during early childhood or develop later in life; the cause is most often unknown or identified as an allergic response of the upper airways to any environmental triggers. An asthma attack cannot only be induced by allergens, but also by sudden changes of air humidity or temperature, as well as inhalation of fumes generated by evaporation of chemicals, or from cooking or heating. Besides inhaled triggers, asthma attacks can result from psychological stress, sports or food allergens. The question which mechanism links all these diverse triggers to develop asthma remains open.

Asthma symptoms can be controlled by inhaled steroids,  $\beta_2$ -agonists, or biologicals such as neutralising anti-

bodies against IgE or pro-inflammatory cytokines. However, the effect of these drugs is relatively short and does not cure the disease. Thus, reducing inflammation alone and relaxing the bronchial muscles is insufficient to cure the disease. The American Thoracic Society suggested in 2017 that asthma might not be cured unless the pathogenesis of airway wall remodelling is understood.

## Asthma research

Unfortunately, there is no clear evidence if all asthma patients have airway wall remodelling or if this is a pathology of a certain subtype of asthma. Studies on airway wall remodelling are limited due to the understandable concerns of the ethics committees, who regard tissue biopsy as an invasive procedure and an unnecessary risk to the patient. Therefore, the suggestion of the American Thoracic Society might be difficult to investigate; especially there is no animal model available, which can simulate all pathologies of human asthma.

Most studies on basic cell research into the pathogenesis of asthma characterise the effect of a single protein or asthma trigger on a specific intracellular signalling pathway and its impact on the proliferation or pro-inflammatory cytokine secretion by inflammatory cells.

Recently, similar studies on the response of tissue forming cells, such as bronchial epithelial cells, smooth muscle cells, dendritic cells or sub-epithelial fibroblasts, have been reported and as such, they have improved our understanding of the pathogenesis. Genetic polymorphisms have been suggested to increase the susceptibility for developing asthma, but a causative link of gene modification and asthma is still missing.

## The search for the cause of asthma

In addition, the search for the cause of asthma included epigenetic studies suggesting a modification of the epigenome during the third trimester of pregnancy and/or the first six years of childhood, which leads to an increased susceptibility for asthma, also later in life. Most of these studies are limited by their focus on a single protein or gene, as a cause of asthma.

The recent introduction of “Big Data” studies and Omics to asthma research has not yielded the expected “Eureka” effect, neither for new biomarkers nor for new therapeutic targets. Little attention has been paid to the fact that intracellular signalling, as well as the interaction of different cell types of each other, are dynamic effects, which depends on the right timing and the right location.

An example may be the studies on TGF- $\beta$  in asthma, which is regarded as the major trigger for remodelling. Depending on the animal model or the target cell type, the effects of TGF- $\beta$  could be contradictory from pro- to anti-inflammatory, or pro- to anti-remodelling. The contradictory results may be explained by the duration of TGF- $\beta$  treatment and the cell type. Moreover, in the asthma patients, it will be rarely the case that only TGF- $\beta$  is upregulated; in over 99% of the cases, a wide range of pro-inflammatory and remodelling stimulating proteins will be increased.

This generates a condition where multiple feedback mechanisms that exist for all pro-inflammatory factors or proteins, are becoming important. Epithelial cells release TGF- $\beta$  when under stress, thereby, they stimulate sub-epithelial cells to produce more connective tissue proteins such as collagens, resulting in thicker airway walls. This effect limits oxygen supply to the tissues, which in turn stimulates proliferation of sub-epithelial cells and formation of new blood vessels, which further thicken the airway wall.

At the same time, epithelial cells and sub-epithelial cells release other pro-inflammatory cytokines, which increase the infiltration of immune cells into the airway and airway wall tissues, therefore, extending inflammation. However, as stated above, most of the pro-inflammatory cytokines can be reduced by anti-inflammatory steroids and biologicals, which does not affect airway wall remodelling.

Several studies including our own indicated that the timing of the medication is crucial to limit airway wall remodelling. Steroids and other anti-inflammatory drugs have the capacity to prevent remodelling when

applied before inflammation takes place. Applying the drugs during inflammation had no more effect on remodelling mechanism(s).

Furthermore, for steroids (major prescribed drugs for asthma), it is known that in some if not all patients, the glucocorticoid receptor is downregulated when the drugs are applied over longer periods. Thereby, the cells want to avoid constant downregulation of essential processes, which are sensitive to hormones.

However, the regulation of the glucocorticoid receptor by synthetic steroids used in asthma therapy seems to be different in animals from humans. Once activated by steroids, the glucocorticoid receptor is transported into the nucleus of the cell, when it binds and regulates specific pro-inflammatory genes. In the rodent model, the glucocorticoid receptor is recycled after it has done its job and is waiting to be activated again.

In the human, the glucocorticoid receptor is degraded after it acted as a gene regulator and new protein has to be synthesised before the cell can respond to steroids again. The de novo synthesis of the glucocorticoid receptor can be inhibited in the presence of pro-inflammatory cytokines, such as TNF- $\alpha$  or IL-1 $\beta$ , while  $\beta$ 2-agonists stimulate its synthesis. Which of the mechanisms is overruling the other has not been thoroughly investigated in humans? Epithelial cells suppress the proliferation of sub-epithelial cells by secretion of so-called heat shock proteins (HSP), especially during stress.

Moreover, HSP stimulates precursor epithelial cells to proliferate and repair the damaged epithelium. Thus, HSP released by stressed epithelial cells exert a dual opposing function, which

depends on the target cell type. In asthma, this control mechanism seems to be non-functional. Furthermore, steroids suppress HSP secretion, which may explain why these drugs have no significant effects on airway wall remodelling; it may rather be that steroids contribute to remodelling.

Despite thousands of studies, the major problem to progress with diagnosis and therapy of asthma seems to be the lack of understanding how different cell types and pro-inflammatory, as well as inflammatory mechanisms affect each other. It would be a big step forward if future studies would be able to monitor a small cohort of patients from the first diagnosis of asthma over one or two years.

The studies should obtain samples like blood, sputum, or bronchial fluids on a regular basis of short intervals (weeks or months), and compare the clinical parameters with metabolomic, proteomic, and transcriptomic methods. The aim of such studies should be to determine if biomarkers and therapeutic targets for asthma vary with time and condition, or if they are stable indicators for the disease.



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# The priorities for supporting people with muscle-wasting conditions

Some of the priorities for supporting people with muscle-wasting conditions and their families are explored here by Open Access Government

According to Muscular Dystrophy UK, muscle-wasting conditions today are very rare, and only affect just over one in every 1,000 people. It's true to say that some health professionals today may never have encountered a patient with a muscle-wasting condition and may not know a lot about them. We'll take a look at some of the issues around muscle-wasting conditions here, including the need to support those with muscle-wasting conditions, the challenges ahead for these people and their families, as well as some of the fascinating research taking place in the field.

## The need for social, emotional and psychological support

Muscular Dystrophy UK's third edition of their *Inclusive education for children with muscle-wasting conditions: a guide for schools and parents* sets out to help meet the need for accessible, up-to-date information on inclusive education for children and young people with muscle-wasting conditions. It's true to say that such a resource can make an important contribution to helping people live as independently as possible.

Robert Meadowcroft, Chief Executive Muscular Dystrophy UK shares his thoughts on the guide, which was completed with the help of members of a working party and the support of the Department for Education. "The guide...offers advice about health issues, emphasising the variability of muscle-wasting conditions, and highlights the need for social, emotional and psychological support. We do hope parents and schools find this revised edition informative and helpful." <sup>(1)</sup>

## Muscle-wasting conditions research

One of the aims of Muscular Dystrophy UK is to support high-quality research to seek effective treatments and cures until they have found them for all muscle-

wasting conditions. As an example of the excellent research taking place in the field, the charity recently highlighted a study which has demonstrated the value of a new mouse model of facioscapulohumeral muscular dystrophy (FSHD). Here, we find out animal models are important for studying the effects of potential treatments, as well as understanding muscle-wasting conditions.

The mouse model originates from Dr Scott Harper and his colleagues at Nationwide Children's Hospital, Ohio, in the U.S. Developing animal models of FSHD has not been an easy task in the past due to the toxicity of the DUX4 protein but to overcome this hurdle, a genetic tool allows Dr Harper and his team to tightly control DUX4 levels in the mice. Dr Harper explains this interesting point further, in his own words.

"Even small amounts of 'leaky' production of DUX4 make it difficult to get the animals to develop properly. To produce the mice we wanted, we needed to control when and where DUX4 would be turned on in mice."

Also, where this research is concerned, we discover that the follistatin gene therapy increased the size of the muscles that it was injected into, plus it improved the strength of these muscles. While such therapy doesn't target DUX4, the results demonstrate that much potential remains for treating FSHD. Dr Harper goes on to detail his own thoughts on this fascinating aspect of muscle-wasting conditions research.

"Follistatin has been shown to be safe when delivered to humans with other muscular dystrophies, such as Becker and Duchenne. While the effectiveness may be limited in those cases, because they are more aggressive, we think that the typically slower progression of FSHD may make it a better candidate for follistatin



therapy. Although more work needs to be done, we believe our study shows that Follistatin gene therapy may prove to be a promising potential treatment for FSHD-associated muscle weakness.”<sup>(2)</sup>

## Changing Places toilet provision at service stations

Let’s now take a look at an aspect of muscle-wasting conditions research highlighted in a recent report from Transport Focus about the disabled user experience on England’s road network. The report suggested a practical measure to support those with muscle-wasting conditions, which is to increase Changing Places toilet provision at service stations on England’s road network. Today, there are only 21 registered Changing Places toilets at service stations throughout the UK. Certainly, current provision is woefully inadequate and prevents thousands of disabled people and their families from travelling due to fears of where they will not be able to use a toilet.

However, it’s not all bad news following the recent announcement that Muscular Dystrophy UK will be working with the Department for Transport to provide £2 million of funding for Changing Places toilets to be installed at motorway service stations in England. By way of background, this funding forms part of the UK government’s Inclusive Transport Strategy, which sets out to provide equal access to the UK’s transport network by 2030.

Commenting the partnership Catherine Woodhead, Chief Executive of Muscular Dystrophy UK, says: “We welcome the Department for Transport’s investment in Changing Places toilets at motorway service stations across England. By building more Changing Places across the road network, disabled people and their families can travel in the knowledge there will be fully accessible toilets they can use safely and with dignity.

“Investing in Changing Places toilets means we can tackle the exclusion many disabled people face. We look forward to working in partnership with the Department for Transport and our campaigners in delivering this project.”<sup>(3)</sup>

## Mental health services

Finally, let’s briefly look at another challenge highlighted by Muscular Dystrophy UK which concerns a lack of access to specialist mental health support for those with muscle-wasting conditions and their families, according to a new Parliamentary report. I think it is fitting then that we leave the last word to Catherine Woodhead, Muscular Dystrophy UK CEO, who shares her own insights into this important matter, which ties in well with the strong theme in this article that concerns supporting those with muscle-wasting conditions by providing them with the right support and resources. “This report shows just how important it is for better recognition and provision of specialist mental health support for all family members who are likely to be affected by the impact of muscle-wasting conditions.”<sup>(4)</sup> ■

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- 1 <https://www.muscular dystrophyuk.org/about-muscle-wasting-conditions/information-factsheets/education-guidelines/>
- 2 <https://www.muscular dystrophyuk.org/news/news/new-fshd-mouse-model-treated-with-gene-therapy/>
- 3 <https://www.muscular dystrophyuk.org/news/news/new-research-on-the-accessibility-of-roads/>
- 4 <https://www.muscular dystrophyuk.org/news/news/new-report-on-gaps-in-mental-health-services-launched-in-parliament/>

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# Duchenne muscular dystrophy (DMD): Correcting the dystrophin gene

Dr Ahlke Heydemann, Associate Professor and Director of Medical School Curriculum at University of Illinois, Chicago explains Duchenne muscular dystrophy (DMD), focussing on the issue of correcting the dystrophin gene

**D**uchenne muscular dystrophy (DMD) is an inherited progressive disease that affects skeletal, diaphragm and cardiac muscles. The pathology initiates with muscle weakness, particularly noticeable on the leg muscles of the young – two to three-year-old – boys. The dystrophin gene is located on the X-chromosome; therefore, it is sex-linked and only boys get the full disease. Women are carriers and can develop cardiomyopathy much later in life. As time goes on, the skeletal muscles continue to weaken, and corticosteroid treatments are initiated, usually at around six years of age.

A few years later, night-time assisted ventilation and then prophylactic ACE inhibitors for the maintenance of respiratory and cardiac function, respectively, are added to the treatment regimen. These combined treatments have extended the quality and quantity of the patients' lives, but more effective treatments or even cures are still urgently required. Within MD, there is some relationship between the specific mutation in the dystrophin gene and the protein levels of dystrophin and the severity of the disease.

The mildest cases are classified as Becker MD (BMD). These mild cases reveal that a relatively low expression level of dystrophin – only 20 to 40 % of normal levels – is required to establish a mild disease course. This very impor-

tant trait can be utilised to set a reasonably achievable goal for a highly beneficial and successful therapy.

## Treatments in the preclinical and clinical trial pipeline

There are many promising treatments in the preclinical and clinical trial pipeline. These can be subdivided into overlapping categories.

- Inflammation/immune inhibitors.
- Modulators of metabolism.
- The reestablishment of the dystrophin glycoprotein complex without dystrophin and
- Gene correction.

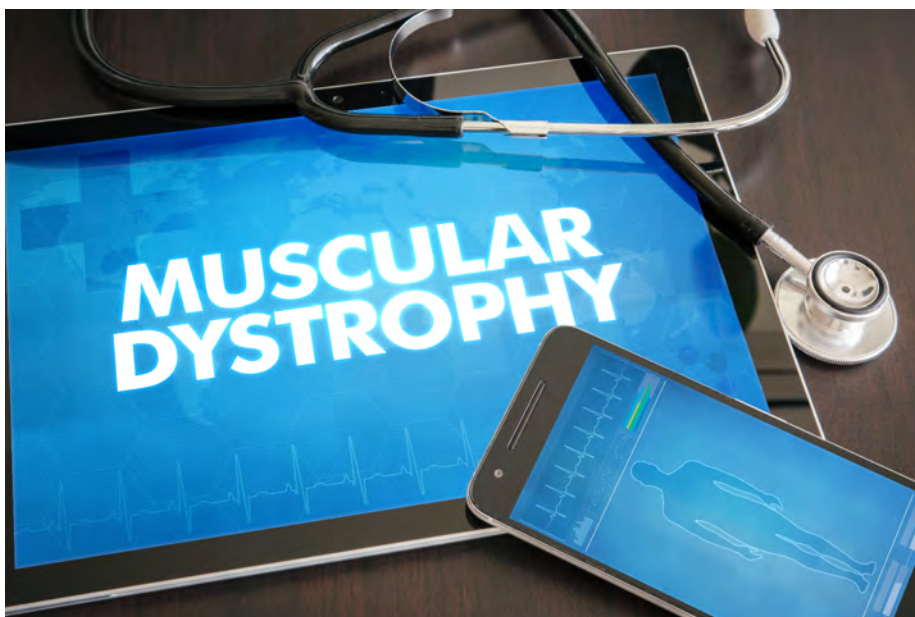
The gene correction strategy can be further subdivided as shown below.

## Gene correction

1. Cell transplantation.
  - a. Stem cells
    - i. Embryonic.
    - ii. Induced.
      1. From normal donors.
      2. From the patient, corrected in vitro
  - b. Muscle satellite cells.
    - i. From normal donors.
    - ii. From the patient, corrected in vitro.
2. Premature stop codon read-through.
3. Exon skipping.
4. CRISPR/Cas.

Utilising cells to reintroduce a wild-type dystrophin gene into diseased muscle has been investigated for many years. Recent progress has given new hope to this particular therapy for MD. Stem cells (SC) can be harvested from a number of sources: embryonic (ESC) tissues or induced (induced pluripotent stem cells) (iPSC) from adult tissues. These SCs have the potential to become permanently engrafted into the host muscles, proliferate, express dystrophin and respond to injury. ESCs have the benefit of being immune privileged, meaning the host tissue will not reject the cells as foreign. However, obtaining the number of ESCs required to treat a patient has been difficult. Proliferating the ESCs in culture causes functional changes that impede their effectiveness in establishing themselves in the host tissue.

One of the benefits of iPSCs is that scientists can produce large numbers without changing their effectiveness for transplant. ESCs are usually derived from normal donors and therefore, contain and deliver the intact dystrophin gene to all muscles that the cells populate. iPSCs can be derived from a normal donor or the patient themselves. If derived from the patient, the genetic defect will have to be corrected while the cells are in culture. An additional step, but a highly effective one, and using the patient's cells ensures that a large immune response will not be



mounted upon transplantation. One of the most positive aspects of this stem cell transplantation approach is that it can be a true cure. If the cells engraft and repopulate the muscles appropriately, they could survive and provide sufficient dystrophin for the life of the patient.

Muscle satellite cells (muscle resident stem cells) are another source of cells that could potentially engraft all muscle groups and be a true cure. These cells are derived from adults and are, therefore, more plentiful and tolerate proliferation in cell culture very well and their use has fewer ethical ramifications. The donor is a normal volunteer or the patient themselves, with the same considerations as mentioned above for the iPSC. Recent work identifies a procedure that fuses normal donor satellite cells with the patient's satellite cells. This results in cells which express dystrophin and are immune privileged. And, as mentioned above, the cells tolerate proliferation, so the clinicians can have a large number of cells available for transplantation.

Clinical trials are also being conducted upon premature stop codon read-

through strategies. This approach is based upon a fortuitous discovery that some antibiotics impede bacterial proliferation by causing the protein-making machinery to ignore the bacterial stop codons, thereby, making longer and less functional proteins. A subset of dystrophin mutations in patients causes a premature stop codon, by the selective use of antibiotic-like pharmaceuticals, the mammalian ribosomes will ignore the stop codon and continue making the remainder of the dystrophin protein, with just one amino acid change, instead of no protein at all. In addition, advanced generation read-through pharmaceuticals have a much higher efficiency of ignoring the stop codon than the original antibiotics, providing higher levels of dystrophin expression.

Recent news has highlighted the success of exon-skipping strategies. This strategy is based upon aligning two synthetic nucleotide strands, with specific sites of the native DNA which causes the normal mRNA processing machinery to skip exons which contain the mutation. So far, this strategy has caused almost normal dystrophin protein to be expressed at close to

therapeutically beneficial levels. Researchers are still perfecting this technique to produce more protein.

The CRISPR system is also being investigated for gene correction in isolated cells from DMD patients and for gene correction within the patient. The final stages of preclinical testing will soon be completed. The exon-skipping and CRISPR systems are largely patient specific. Therefore, each patient will require specific chemistries to guide the editing machinery.

The further good news is that these genetic correction strategies can be utilised with other strategies that treat the symptoms to provide the most patient benefit with the lowest side-effects. Very importantly, transplantation, read-through and exon skipping studies are currently being tested in patients for efficacy. In the near future, multiple options will be available for clinicians and their patients to combat this disease.

## PHYSIOLOGY AND BIOPHYSICS COLLEGE OF MEDICINE



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# Therapies for weak muscles

Research into personalised interventions is helping pave the way for a new generation of therapies for weak muscles at the Balgrist Campus

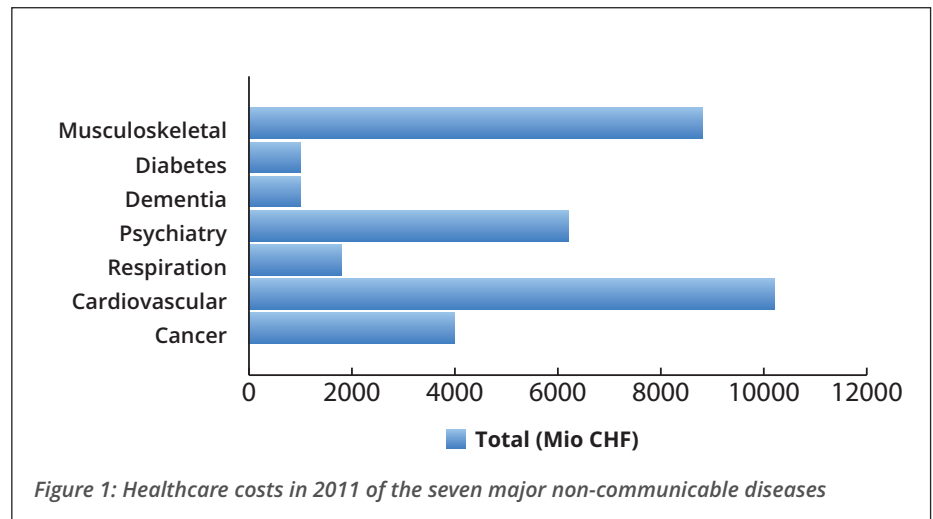
It is estimated that 10% of the cost of healthcare in Switzerland (or the equivalent of €500 billion per annum in the EU) being associated with lost work is related to injury or dysfunction of the musculoskeletal system (Fig. 1). Surgical and subsequent rehabilitative interventions are important part of the therapy that re-establishes musculoskeletal function.

The Laboratory for Muscle Plasticity at Balgrist University Hospital aims to shed light on the underlying mechanisms in skeletal muscle with the goal of translating the findings into more effective clinical applications.

Skeletal muscle plays a major part in control of movement and posture and affects whole body metabolism through its effects on energy expenditure. Affections ranging from simple overuse injury to rupture of tendons and bones, or disease, lead to deconditioning of skeletal muscle as a result of inactivity and damage signals. The consequent loss in muscle strength and fatigue resistance exerts a distinct negative impact on the quality of life and may render the affected individual dependent. In these situations a surgical intervention and rehabilitation may be indicated, yet may come too late as irreversible changes may have resulted.

## Focus on muscle plasticity

The Laboratory for Muscle Plasticity investigates the mechanisms that



underlie the conditioning of skeletal muscle structure and function during recovery from surgical interventions and rehabilitation. As shown through research on sport performance, this process is driven by mechanical and metabolic stimuli. It is mediated through a gene response that instructs adjustments in muscle composition with the repeated impact of exercise during training. In consequence, force production and fatigue resistance of muscle may be improved or maintained.

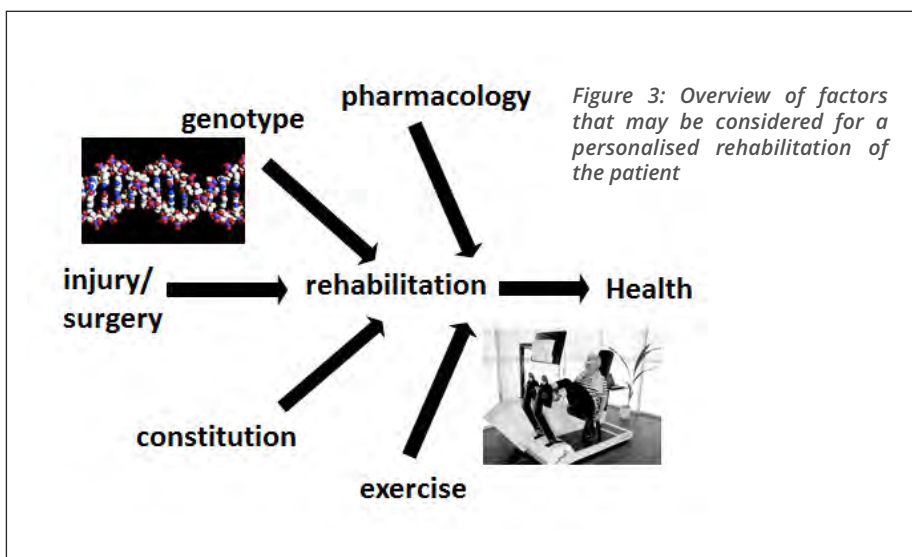
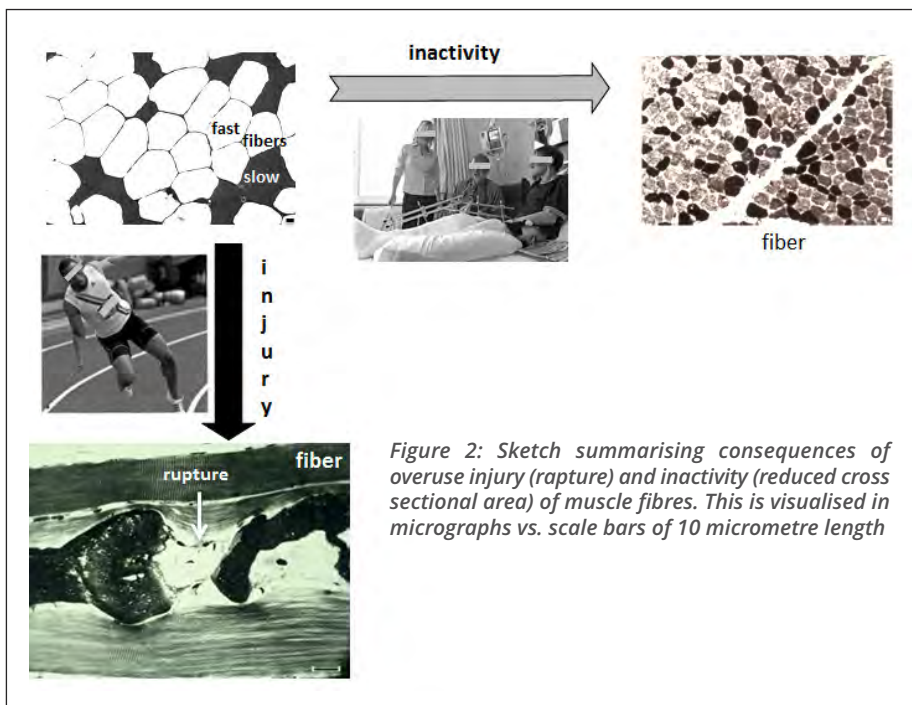
By contrast, a muscle's functional capacity is reduced in the absence of a physiological stimulus by a reduction in the size of muscle fibres and their content in mitochondria (Fig. 2).

In fact, while the safety and effectiveness of physical factors for muscle conditioning are well established, the dose-effect relationship between

exercise and muscle adaptation is often not fully respected in clinical practice. An example of this biological regulation is the important role of muscle contraction and loading in preserving muscle mass of the bedridden musculoskeletal patient after surgery, who would otherwise lose muscle mass at a pronounced rate. Genetic factors (so called gene polymorphisms) significantly affect this adaptation. This indicates that gene polymorphisms contribute to the inter-individual variability of the response to surgical interventions and rehabilitation.

## Research projects

The emphasis of the research team lead by Prof Martin Flück at Balgrist is on major musculoskeletal affections that arise in the context of the orthopaedic clinics at Balgrist Hospital. A special focus is put on resolving the contribution of gene polymorphisms



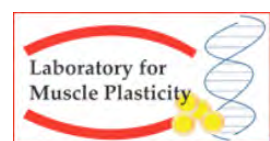
to inter-individual differences in the healing of muscle with re-attachment of the ruptured rotator cuff tendon, and the strengthening of skeletal muscle with rehabilitative exercise in patients.

The aim is to develop personalised forms of intervention that maximise muscle adaptation (Fig. 3). The latter approach is based on previous investigations pointing out the important exercise-intensity and exercise-type related influence of gene polymor-

phisms on muscle response to leisure-type sports activities. This opens a venue to tailor the therapeutically effective exercise intervention for patients which otherwise would demonstrate little plasticity to a generic exercise stimulus and for which pharmaceuticals alone do not work due to the importance of activity-induced muscle metabolism for muscle adaptations. In this regard, the clinical investigation ACE-REHAB into personalised rehabilitation of cardiac patients has been initiated.

## Patient-led research

The laboratory is situated in state-of-the-art research facilities at the Balgrist Campus. A key ingredient of this research facility is an open-space landscape where research and development into musculoskeletal medicine is integrated under one roof between clinicians, biologist, engineers, and industry. The facility situates in the vicinity of the orthopaedic hospital at Balgrist; thus providing a pipeline for a reality-driven approach that re-integrates questions from bedside to bench and returns to the patient. The Laboratory for Muscle Plasticity is looking for potential partners that may want to exploit the research options presented in the future campus in the frame of collaboration.



# The Balgrist

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# Research into deafness, hearing loss and tinnitus: Towards a cure

Chief Executive for Action on Hearing Loss, Mark Atkinson charts the priorities for research into deafness, hearing loss and tinnitus towards a cure

Most people take their hearing for granted, but its loss can be devastating – cutting people off from their friends and family, affecting their health and wellbeing, education and employment. Recent research shows that the risk of developing dementia is increased two to five-fold amongst those with hearing loss. It is also associated with huge economic costs. To put it in perspective, the World Health Organization estimates that globally unaddressed hearing loss costs around \$750 billion every year.

It is a global issue affecting over 460 million people around the world, 11 million people in the UK alone – that is one in every six of us. And, with 1.1 billion young people at risk of developing it due to listening to high levels of recreational noise and living longer in general, it is a growing issue that society must urgently tackle.

Yet, despite the vast numbers of people affected and its impact, medical treatments for hearing loss have remained largely unchanged for decades – limited to hearing aids and cochlear implants. Whilst these devices deliver significant benefit, they cannot replace natural hearing and many people using them still struggle to hear well – particularly in noisy environments.

That's why the research we fund into hearing loss is so important. We want to find effective treatments to prevent hearing loss, therapeutics to restore hearing for those who choose to use it, and treatments to silence tinnitus that affects more than 6 million people in the UK alone.

## New treatments

Hearing loss can be caused by exposure to loud noise, ageing, gene defects, infections and the harmful side effects of certain life-saving medicines. As our understanding of these factors has grown, it has opened the

door to the development of drugs to help prevent them.

Our own research, for example, has helped to identify a gene that increases susceptibility to noise-induced hearing loss, and shown that a drug can reduce the risk in animals. Pragma Therapeutics, a French biotech company, now plans to take the drug into clinical trials. Hearing loss is one of the most common disabilities among veterans, so a drug treatment to prevent this type of hearing loss is of particular interest to the armed forces.

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**“Excitingly, several deals have been made between big pharma and smaller companies in recent years. In one promising partnership, Novartis’ gained exclusive rights to Genvec’s gene therapy that aims to restore hearing. Novartis has now taken it into clinical trials. So, big pharma is standing ready to bring promising new treatments to market as they emerge.”**

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Our ears are unable to replace many of the cells and structures that cause hearing loss when damaged. That is why most hearing loss is permanent. One approach to restoring hearing is to understand how the ear produces these cells during development, and then find a way to reactivate these processes in a damaged ear. Amazingly, scientists have already discovered some of the genes and biological processes involved, and treatments to activate them are already being clinically tested.

An alternative approach, which we have been supporting, is to use stem cells to replace damaged auditory cells. Scientists in Sheffield are making rapid progress towards this goal. They have shown that it is possible to generate auditory neurons – the cells that carry information about sound from the ear to the brain –





*Mark Atkinson, Chief Executive for Action on Hearing Loss*

from human stem cells in the lab. And, that these cells can then be used to repair damaged nerves recovering on average 45% of hearing in animals.

### **Growing investment in clinical research**

There are currently over 20 different treatments in clinical trials and pharmaceutical companies, and encouragingly big investors are helping move promising treatments through clinical trials.

Between 2013 and 2017, \$299 million of venture funding was secured by companies developing treatments for hearing loss, compared to just \$86 million in the preceding five years (BioCentury, 2017).

Excitingly, several deals have been made between big pharma and smaller companies in recent years. In one

promising partnership, Novartis' gained exclusive rights to Genvec's gene therapy that aims to restore hearing. Novartis has now taken it into clinical trials. So, big pharma is standing ready to bring promising new treatments to market as they emerge.

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**“Recent research shows that the risk of developing dementia is increased two to five-fold amongst those with hearing loss. It is also associated with huge economic costs. To put it in perspective, the World Health Organization estimates that globally unaddressed hearing loss costs around \$750 billion every year.”**

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Remarkable progress is being made and we are now within touching distance of a new era for people with hearing loss and tinnitus, one in which drug, gene and cell therapies promise to transform their lives. Now is the time for charities, statutory funders and industry to increase investment in developing treatments for hearing loss. ■

To help fund our research into treatments for those seeking them, please donate: [www.actiononhearingloss.org.uk/donate](http://www.actiononhearingloss.org.uk/donate) .

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# Supporting biomedical research: A focus on hearing loss

The work of the National Institute on Deafness and Other Communication Disorders (NIDCD) in the United States is profiled here, with a focus on their work around helping those with hearing loss, as well as tips to prevent it and their hopes for the future

The National Institute on Deafness and Other Communication Disorders (NIDCD) is one of the many parts of the National Institutes of Health (NIH) in the United States today. By way of an introduction, it's important to know that NIH is the federal government's focus where the support of biomedical research is concerned. In essence, the NIH's mission is to unveil new knowledge that will result in better health for everybody. In very simple terms, the aim of NIH research is to gain new knowledge to help prevent, detect, diagnose and treat both disease and disability.

It's very fitting that we're looking at the work of NIDCD here as they have recently celebrated their 30-year anniversary, established in 1988 and since then they have been supporting research that has led to remarkable discoveries in hearing, balance, smell, taste, speech, voice plus language. Their work has brought into focus disorders of human communication plus an impressive contribution to biomedical and behavioural research that improves and advances the lives of millions of people with communication disorders.<sup>1</sup>

## Advancing research to improve lives

Judith A. Cooper, PhD, acting director of the NIDCD and director of the NIDCD Division of Scientific Programs highlights in a message for this 30th anniversary that at least 20% of adults in the U.S. have a significant impairment where hearing, balance, taste, smell, voice, speech, or language are concerned. In her view, the basic components of communication (sensing, interpreting and responding to their environment) can be challenging for these people.

Let's now focus on the hearing aspect of NIDCD, indeed, according to Judith, a number of factors contribute to hearing loss, as well as balance dysfunction, which can

happen at any age and impact upon communication, safety and the quality of life. In her own words, Judith explains NIDCD's research aims in this vein, as well as her thoughts on hearing aids and cochlear implant technology.

"The NIDCD's robust program of basic and clinical research on hearing and balance includes genetics, genomics, and proteomics. This research focuses, in part, on the identification of genes involved in hearing loss to lead to earlier diagnosis and treatment, and to new therapies.

"Nearly 30 million adults in the United States could benefit from using hearing aids, but only one in four has used them. The NIDCD supports innovative clinical and translational research to lay the foundation for making hearing health care more accessible and affordable. Current research includes identifying barriers to care and assessing novel service delivery and screening models.

"Researchers are also applying cochlear implant technology to develop other neural prostheses. These devices will, for example, provide a sense of hearing for people whose auditory nerve is removed or damaged; normalize balance by electrically stimulating the vestibular nerve; and help patients with severe speech and physical impairments express themselves using speech synthesized from brain-computer interfaces."

## Takings steps to protect your hearing

One initiative to highlight here is the one that took place during October 2018, which was National Protect Your Hearing Month, and at the time, the NIDCD promoted noise-induced hearing loss (NIHL) and the steps you can take to prevent it, which we'll highlight

here. One important point in this vein is that sounds that are too loud for too long can damage your hearing permanently, indeed the louder the noise, the quicker it can damage hearing.

Incredibly loud noises can damage your hearing for life, and in just 15 minutes your hearing can be damaged by listening to loud music on headphones or attending a concert, for example. It's also worth bearing in mind that lower levels of noise over prolonged periods can also damage human hearing, an instance of which is those working in a noisy yard using farm equipment. The NIDCD also stresses that when sounds are too loud for too long, "tiny bundles of hair-like structures that sit on top of hair cells in the inner ear are damaged."

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**"The NIDCD's robust program of basic and clinical research on hearing and balance includes genetics, genomics, and proteomics. This research focuses, in part, on the identification of genes involved in hearing loss to lead to earlier diagnosis and treatment, and to new therapies."**

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The NIDCD provides the following helpful hints to protect your hearing:

- Reduce the volume. Know which noises can cause damage is important for those at or above 85 decibels. If you use headphones or earbuds, it is vital to ensure that the volume is always low.
- Move away from the noise. The advice here is that if you are unable to lower the volume, create some distance between you and the source.
- Wear hearing protectors, such as earplugs or earmuffs, when you're involved in a noisy activity is very important. This could be done whether you are using power tools, mowing the lawn, playing loud music or attending a loud sporting event or a concert. Activity-specific earplugs and earmuffs can be purchased online and at sporting goods, hardware, as well as other stores.
- Protect the ears of children who are not old enough to protect their own.
- Spread the news to your family, friends and colleagues about noise hazards.<sup>2</sup>

### NIDCD-supported research in the future

Looking at the wider picture, we know that NIDCD-supported research also concerns voice, speech, and language impairments linked to stroke, injury and neurodegenerative disorders, such as Parkinson's disease. Such communication problems, like aphasia, apraxia and dysarthria frequently lead to a poor quality of life and increased isolation for an individual.

Looking ahead, Judith A. Cooper, PhD, acting director of the NIDCD and director of the NIDCD Division of Scientific Programs paints a picture of a journey towards brand new frontiers in precision medicine and scientific discovery and she believes that the NIDCD is in a very good position to support innovative studies to produce more effective, sensitive, and individually tailored interventions. We leave the closing words of this article with Judith herself who underlines that the NIDCD's research will expand in the future to help people of all ages who are experiencing the challenges of communication disorders, including, of course, hearing.

"NIDCD-supported researchers are dedicated to expanding our understanding of hearing, balance, taste, smell, voice, speech, and language and improving rehabilitation strategies for children and adults who face the challenges of communication disorders."<sup>3</sup> ■

For more information on hearing, ear infections and deafness, go to: [www.nidcd.nih.gov/health/hearing-ear-infections-deafness](http://www.nidcd.nih.gov/health/hearing-ear-infections-deafness)

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# The genetically modified chicken: A sound approach to the study of hearing

Jason Tait Sanchez, Assistant Professor at Northwestern University provides insight into why the genetically modified chicken is a sound approach to the study of hearing. We discover how tonotopic properties are established in the chicken auditory brainstem by using novel and innovated genetic research methods

It is well established that the chicken is a valuable research tool to study basic biological questions in numerous health-related areas, including immunology and infectious diseases<sup>1,2</sup>.

Recent applications of gene editing in chickens also suggests an innovative era is on the horizon for developmental and sensory neurobiology as well<sup>3,4</sup>. With respect to hearing development, mammals and birds share comparable auditory functions at the cellular, synaptic, and neural circuit level<sup>5,6</sup> and both species encode sound similarly across the frequency axis, a process known as tonotopic tuning<sup>7,8</sup>.

Tonotopy is the spatial arrangement of where sounds of different frequencies are processed. Tonotopy originates along the peripheral sensory epithelium and is preserved throughout the entire auditory system. Tonotopy in the central auditory pathway is arranged not only by the specific locations of neurons and their inputs, but by differences in their structural and functional properties along the tonotopic axis<sup>9,10</sup>. Exemplars of this are found in the mammalian anteroventral cochlear nucleus and the chicken cochlear nucleus magnocellularis (NM), which are analogous, first-order auditory brainstem structures. In this article, I will provide recent insight into how tonotopic properties are established in

the chicken auditory brainstem by using novel and innovated genetic research methods.

## Development of tonotopic properties

Despite more than a half-century of work on the development of tonotopic properties in the peripheral auditory system (i.e., the cochlea), little is known about its establishment in the central auditory system<sup>11</sup>. This fundamental lack of knowledge is noteworthy, and several questions warrant discussion.

First, do tonotopic properties emerge from indiscriminate connections, or are there precise projections early in development? If precision exists early on, does refinement improve with maturation? Anatomical evidence argues that the topography of connections between the periphery and central pathway develops with considerable precision, well before hearing onset, and with substantial refinement thereafter<sup>12-18</sup>.

Second, what role, if any, does spontaneous neuronal activity – as opposed to sound-driven activity – have on the development or maintenance of tonotopic properties? Physiological studies show that early in development, functional mapping along the tonotopic axis supports precise tuning independent of sound-driven activity<sup>19-23</sup>.

Finally, what are the molecular and cellular signals responsible for establishing and maintaining distinct neuronal phenotypes along the tonotopic axis in the central pathway? The answer to this final question remains elusive, making it a significant and timely problem in developmental and sensory neurobiology in general<sup>3</sup>.

## Potential genes-of-interest

One thing is clear, however; both presynaptic axons and postsynaptic target neurons express genes – like neurotrophins – that may be responsible for establishing tonotopic properties in the central pathway. Neurotrophins, along with their cognate receptors, are growth factor proteins that support numerous aspects of normal nervous system development<sup>24-27</sup>, and irregular neurotrophin signalling is implicated in pathophysiological conditions in both the peripheral and central nervous systems<sup>28-30</sup>. This makes them a critical factor that promotes normal and abnormal biologically relevant properties<sup>31</sup>.

The idea that neurotrophin signalling is important for the tonotopic establishment in the auditory system is supported by the following observations from the chicken NM.

First, the retraction of neuronal dendrites takes places along a spatial gradient that matches the tonotopic

axis<sup>32</sup>. Mid- to high-frequency NM neurons lose their dendrites while low-frequency neurons maintain them.

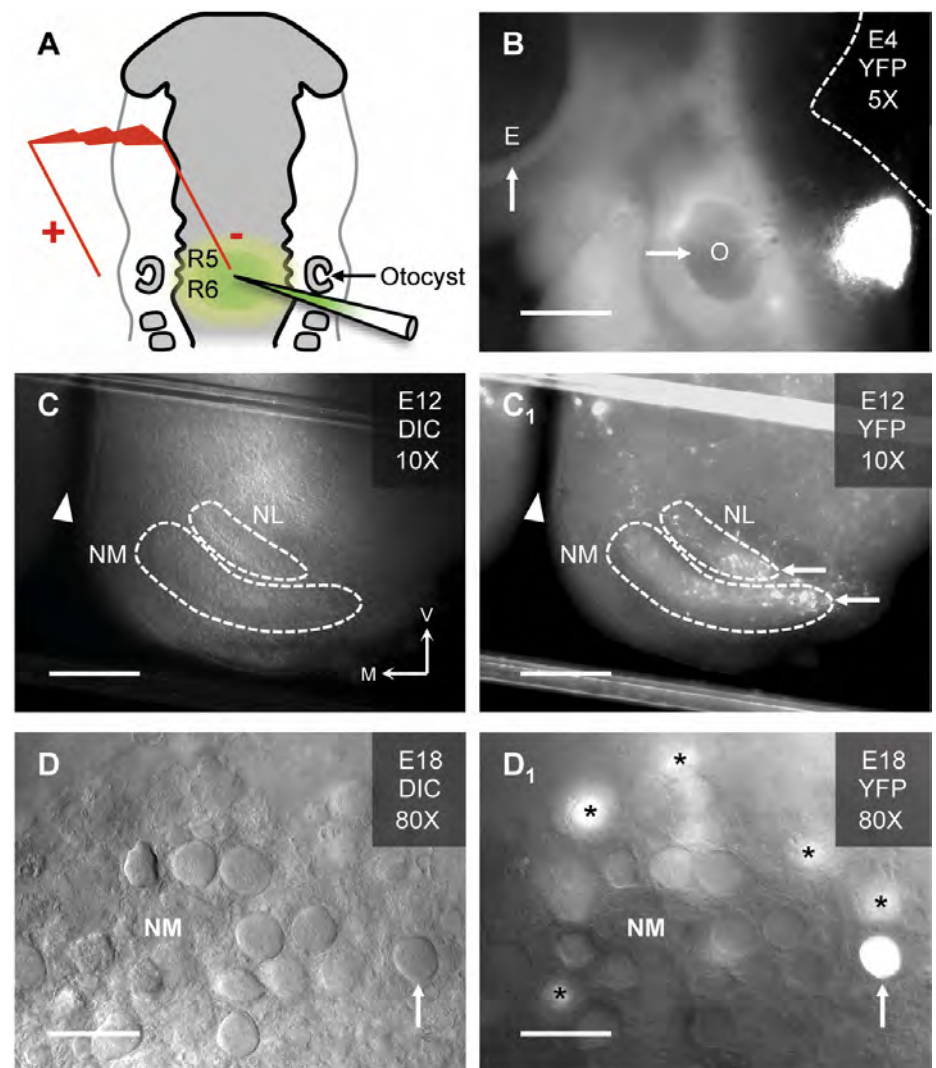
Second, the expression pattern of a very specific neurotrophin receptor (known as TrkB) is spatially and temporally dynamic; TrkB is present at embryonic (E) day 7, significantly reduced by E15 and absent at hatch (E21), but only in mid- to high-frequency regions<sup>33</sup>.

Third, this expression pattern parallels a developmental period when functional properties are also differentially established along the tonotopic axis<sup>34-37</sup> and coincides with hearing maturation<sup>38</sup>.

Finally, genetically modified maintenance of TrkB receptors in mid- to high-frequency NM prevents dendrite retraction and promotes aberrant neuronal excitability<sup>39</sup>, properties that more closely resemble their low-frequency neuronal counterparts<sup>10,40</sup>. The dynamic expression pattern of TrkB receptors regulates the development of distinct tonotopic properties found in NM and strongly supports the hypothesis that neurotrophin signalling establishes different neuronal phenotypes along the tonotopic axis in the central auditory pathway.

## Why the chicken?

The chicken is an ideal model system over other mammalian research tools because they have tonotopic properties more commonly shared with humans. Chickens, like humans, utilise both low- and high-frequency sounds to perform behaviourally relevant auditory tasks, such as sound localisation and signal discrimination<sup>41,42</sup>. This is unlike most mammalian research models, such as mice and rats, which rely primarily on ultrasonic hearing.



**Figure 1. In ovo electroporation in the chicken auditory brainstem**

(A) Schematic of electroporation in the hindbrain of a Hamburger Hamilton (HH) stage 12 chicken embryo. The injection pipette is filled with plasmid DNA and fast green dye for visualisation of the injected hindbrain (rhombomeres 5/6 [R5/R6]). In this study, a plasmid that coexpressed the gene-of-interest and the yellow fluorescent protein (YFP) reporter was used. Electroporated embryos are further incubated until the desired developmental stage is reached. (B) Embryonic (E) day 4 chicken showing the site of YFP expression relative to the left eye (arrow, E) and left otocyst (arrow, O). The dashed white line represents the dorsal brain and brainstem border. Scale bar = 480 μm. (C & C1). Brainstem slice (300 μm thick) from an E12 chicken under differential interference contrast (DIC, C) and fluorescent (YFP, C1) illumination. Dashed white lines represent the borders of nucleus magnocellularis (NM) and nucleus laminaris (NL). Note, the brainstem slice shows only one side of the tissue. White arrowheads represent midline cleft of the brainstem slice. White arrows show YFP expressing regions of NM and NL. V = ventral, M = medial. Scale bar = 240 μm. (D & D1). High magnification (80X water immersion objective) of an E18 chicken brainstem slice containing NM. The classic adendritic cell bodies<sup>37</sup> are clearly visible under DIC illumination (upward arrow, D). With fluorescent illumination for the same slice, a transfected NM neuron identified by YFP fluorescence is clearly visible (upward arrow, D1). Asterisks = YFP expressing NM neurons just below the focal plane. Scale bar = 30 μm. Figure from Lu et al., 2017<sup>48</sup>.

With respect to the development of hearing acuity, chickens (like humans) are also precocious animals. The chicken's auditory system is near functional maturity at hatch, and the onset and refinement of hearing occur during embryonic stages<sup>38</sup>. This is unlike other low-frequency hearing

mammalian research models (e.g., gerbil, guinea pig), whose hearing emerges ~10-16 days postnatal<sup>43</sup> and are susceptible to extrinsic factors that influence development.

Finally, the spatial and temporal expression of limited neurotrophin

factors in the chicken NM<sup>33,44</sup> provides a novel opportunity to evaluate highly-specific neurotrophin signalling and its role in establishing neuronal topology. This is unlike the mammalian auditory system, which expresses many more neurotrophin factors across numerous developmental periods<sup>45</sup>, ultimately confounding the study of neurotrophin signalling in regulating tonotopic development in these species.

**“Our research aims at addressing these issues by providing a comprehensive understanding of neurotrophin signalling and its role in establishing neuronal phenotypes along the tonotopic axis in the developing auditory brainstem, a biologically relevant structure which is essential for sound processing.”**

### A sound approach

Electroporation is a method that introduces genes into biologically relevant organisms like the chicken embryo. In ovo electroporation is a formidable tool to study neuron-specific development in the auditory brainstem<sup>3,46</sup>. It permits the over-expression or knock-down of specific genes-of-interest (like neurotrophin factors) in order to analyse in vivo gene function<sup>39,47</sup>. We and others have recently introduced genetic methods to obtain focal, stable and temporally regulated transgene expression of neurotrophins at multiple stages of chicken embryo development<sup>3,39,48</sup> (Fig. 1). It is advantageous over mammalian model systems for several reasons. First and foremost, because electroporation is performed in ovo, it permits gene expression in a normally developing biological system.

Second, genes are focally injected, allowing spatial control of expression in highly specific brain regions<sup>49</sup>. Third,

genes are temporally regulated by drug applications, enabling expression at precise developmental time periods<sup>39,48</sup>.

Finally, genes are only expressed by a subset of neurons, allowing non-transfected neurons to serve as internal controls. This provides a rigorous and quantitative comparison of the neuron-autonomous effects of gene expression. The in ovo electroporation technique – together with either biochemical, pharmacological, and or in vivo functional assays – provides a genetic approach to study auditory neuron development associated with tonotopic differences in neuronal structure and function, as well as associated pathophysiological phenomena.

Indeed, a better understanding of normal auditory circuit assembly – along with unique structural and functional properties associated with tonotopic gradients – will provide a significant foundation for developing stem cell-based therapies for auditory-related disorders. However, stem cell-derived auditory neurons will only prove useful – therapeutically – if they are able to re-create neuronal properties that are characteristic of normal circuit maturation<sup>50</sup>. A careful characterisation of neurotrophin signalling, the underlying molecular mechanism by which it operates, the role it plays in establishing normal neuronal properties, and the functional consequence of altering this biological process is necessary and appropriate.

Our research aims at addressing these issues by providing a comprehensive understanding of neurotrophin signalling and its role in establishing neuronal phenotypes along the tonotopic axis in the developing auditory brainstem, a biologically relevant structure which is essential for sound processing.

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# Cutting-edge technology synergy in the personalised nanomedicine space: Focus on pharmaceutical nanomanufacturing

Cecilia Van Cauwenberghe from Frost & Sullivan's TechVision Group explains cutting-edge technology synergy in the personalised nanomedicine space, with a special focus on pharmaceutical nanomanufacturing

In terms of understanding nanomedicine space in the personalised medicine context, this is inherently an interdisciplinary research field that involves the application of nanotechnology to medicine. Nanomedicine has been significantly energised during the past five years with the advent of new technology innovations across many industries. The nanomedicine space has been as well re-shaped to better adapt to the precision medicine era.

Personalised medicine looks for developing specific treatments based on direct omics-based data from either an individual patient or a group of individuals with common characteristics or a cohort. Personalised treatments take into consideration genetic and phenotypic factors, along with environmental aspects that are expected to impact upon therapy response and further evolution. Nanomedicine is prone to have a magnificent impact precisely on the field of personalised medicine in the near future, mainly due to its design flexibility and target versatility to adjust a drug to a specific cohort of patients, while providing superior specificity and efficacy.

## The exciting nanoscale world

In a review paper on nanomedicine published during the past year (Fornaguera and García-Celma, 2017), the authors categorise several common advantages of nanomedicines among conventional therapies, despite the nanoparticle type and origin (polymeric, magnetic, liposome, vesicle, etc.). According to the authors, such attributes are mainly related to their nanoscale dimensions, target specificity, application versatility, labile actives encapsulation and protection, pharmacokinetics and pharmacodynamics alteration, biological barriers

penetration (e.g. blood-brain-barrier), design customisation for particular cohorts and treatment plans (e.g., dosage, frequency, timeline), easy surveillance and adherence, among many other features. However, all these properties can be enhanced or better applied through the introduction of novel and innovative technologies across the entire nanomedicine value chain.

## Unveiling pharmaceutical nanomanufacturing

### Electrohydrodynamic atomization

Electrohydrodynamic atomization (EHDA) or electro-spraying enables the fabrication of nanoparticles by the application of an external electric force. This method can be easily multiplexed and scaled up. The therapeutic product and the polymer are infused through a nozzle to be subjected to a high voltage, so that, the electrically charged solution is broken into smaller droplets. These droplets are then reduced to nanoparticles by solvent evaporation. One of the main advantages of EHDA is that both hydrophobic and hydrophilic drugs can be encapsulated efficiently, while particle size and size distribution can be exceptionally controlled at the nanoscale (Labbaïf et al., 2014; Agrahari and Agrahari, 2018). The main therapeutic applications associated with this nanomanufacturing technique are related to anti-cancer chemotherapy, due to it facilitating the targeted delivery of powerful chemotherapeutics with precise payload and release control (Parhizkar et al., 2017; Sengupta, 2017).

### Pressurised gyration

Nanofibers have revolutionised healthcare through its application to a plethora of biomedical functions,

including filtration, nanobiosensors within smart textiles and wearables, wound healing patches, tissue engineering and regeneration scaffolds, as well as drug delivery harpoons (Parhizkar et al., 2018). Pressurised gyration simultaneously applies a high rotating speed and a great working pressure to spin nanofibers and nanofibrous structures, hence presenting a high surface area to volume ratio, flexibility and surface functional properties. Similarly, pressurised gyration can also generate microbubbles that hold an enhanced stability and capability to optically tune infrared and visible wavelength ranges (Van Cauwenberghe, 2015). These characteristics make microbubbles potentially applicable for nanotherapeutics surveillance through bioimaging markers and other nanobiosensing approaches (Rajan, 2017).

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**“Nanomedicine is prone to have a magnificent impact precisely on the field of personalised medicine in the near future, mainly due to its design flexibility and target versatility to adjust a drug to a specific cohort of patients, while providing superior specificity and efficacy.”**

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## Final remarks

The identification of new nanoparticle materials and nanostructures manufacturing is crucial to empower nanopharmaceuticals. Delivering therapeutic agents to the target tumour sites is the priority in most of ongoing nanomedicine projects today. Parallel trends in nanomanufacturing, with the advent of 3D printing technologies and advanced manufacturing techniques such as electrohydrodynamic atomization and pressurised gyration, are gaining attention in the construction of novel nanotech systems and the rational design of nanoparticles based on an in-depth understanding of the behaviour of nanoparticles. The market is significantly reflecting those investigational trends with the appearance of new commercially available products and a large number of nanocompounds in clinical development. Anti-cancer therapies are certainly the most targeted applications in nanomedicine products, followed by neuroscience and diverse drug delivery products. More than 47% of nanomedicine products in development are related to acutely life-threatening conditions, mostly advanced cancers.

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# Novel materials and nano-risk in the semiconductor industry

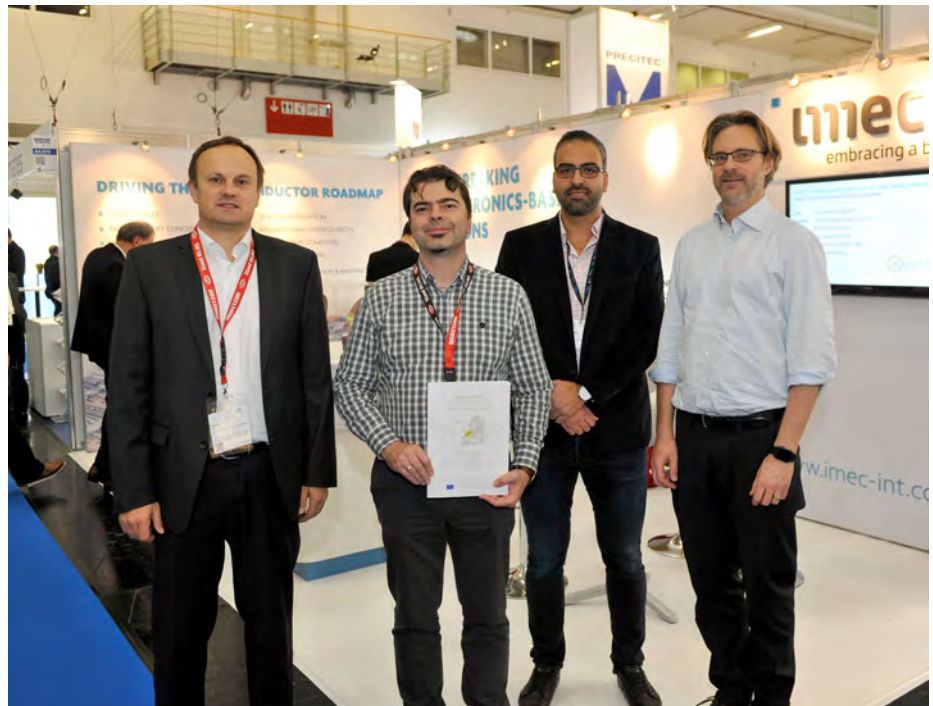
Dr Dimiter Prodanov from Imec explains the guiding principles in technological development of novel nanomaterials

**N**anomaterials are fascinating for the wide variety of their unique properties, which can be used to improve everyday life. Such desirable characteristics can include the increased strength of the nano-enabled material, its chemical reactivity or altered electrical properties. Deliberately designed, that is, engineered nanomaterials (ENM) are used in a wide variety of applications, from cosmetics and paints to sportswear and semiconductor chips. Use of ENM rests at the core of modern nanotechnology.

## Top-down and bottom-up approaches to nanotechnology

From a technological perspective, there are two complementary approaches to nanotechnologies: a top-down and a bottom-up manufacturing. While the bottom-up approach can be broadly identified as nanoparticle synthesis or self-assembly; the top-down approach consists of growth or deposition on surfaces often in combination with nano-patterning techniques. An example of the latter is in the nano-electronics industry. In the broad sense, end-user nanomaterial industries are also nanotechnological since they incorporate engineered nanomaterials into macroscopic objects.

The precautionary principle advises that some ENM may have enhanced or altered toxicity compared to their bulk counterparts. Examples here are various nanofibers or photocatalytic nanoparticles. While for chemicals



*Speakers of the Workshop "Novel materials and nano-risk in semiconductor industry" visiting the Imec booth at Semicon Europa, Munich, 14th Nov 2018. From left to right: Michael Jan, Fraunhofer IISB; Dimiter Prodanov, Imec; Salim El Kazzi, Imec; David Carlander, Nanotechnology Industry Association*

there are established regulatory frameworks dealing with the potential risks to consumers, workers and the environment, this is not the case for nanomaterials. Safe-by-design approaches in nanotechnology are, therefore, increasingly being explored by regulators and policymakers in Europe. While in mature industries, such as in construction, these can easily be decoded into specific engineering requirements for the construction of buildings or bridges, the safe-by-design concept for nanomaterial synthesis, representing bottom-up nanotechnology, remains somehow abstract. It could be, therefore, be useful to

transfer experience from other, more technologically mature sectors, such as integrated circuit manufacturing.

The technologies used in nanoelectronics offer an unprecedented control of the properties of the finished product at an affordable cost and high yield of the finished devices. To do so, the nanoelectronics industry introduces a variety of novel materials, which are used at the nanoscale level. Typically, the product development runs ahead of establishing precise limits for the occupational and environmental hazards of these materials. Since nanoelectronics research and development



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*An outlook of the Imec FAB300 clean room facility*

(R&D) deals with novel materials and processes, the challenge is the lack of information leading to uncertainty in risk grouping and governance.

## **NanoStreeM to set up the nano-safety roadmap in semiconductor R&D**

Since 2016, the NanoStreeM project<sup>1</sup> has developed a framework for a safety assessment of new nanostructured materials, for example, quantum dots, different types of nanofibers, or 2D materials, such as nanosheets like graphene. By performing an extensive literature review, the team of Dr Michael Jank from the Fraunhofer Institute for Integrated Systems in Erlangen, together with colleagues from IMEC, Belgium, have established some guiding principles in technological development. These can be summarised as follows:

- Lab-scale research typically employs the direct handling of ENM in a bottom-up manner, which can pose occupational but not consumer or environmental hazards. This is because the deployed technologies are of low maturity (that is not present in finished products) and small scale.

- As the technology becomes more mature, the yield requirements lead to innovations that favour precisely aligned and reproducible placement and, therefore, avoid direct handling of ENM. Workers are not likely to get exposed since processing favours closed systems. At this stage, free nanomaterials may be present during some processing stages, but the consumer is not directly exposed to them during the intended use of the finished product.

- Finally, mature technologies for ultra-large-scale integration (ULSI, see photo above) because of their performance and yield requirements, lead to the deployment of approaches, which are compatible with the present planar technologies, based on silicon and germanium. That is, nanostructures are patterned in a top-down manner which avoids direct exposure to the ENM and, therefore, reduces both occupational and consumer exposure. Therefore, top-down fabrication of nano-functionalised materials and devices is unlikely to add unanticipated hazards only because used materials are “nano”.

The results of the study have been discussed by an expert panel held at a satellite workshop at Semicon Europa, Munich on 14 Nov 2018 (see photo). The panel agreed that the R&D approach in semiconductor industry represents an example of the safe-by-design approach that may have some generic properties transferable to other industries. Furthermore, the existing European regulatory risk assessment approach, represented by the REACH Regulation 1907/2006 and the Chemical Agents Directive, in combination with the ISO Standard ISO/TS 12901-2:2014 can also be suitably used for the novel materials deployed by the semiconductor R&D. However, more attention is needed in assessing possible environmental hazards at the end-of-life of different products and the possibilities for recycling of rare elements. The full workshop report is available on the NanoStreeM [website](#).

<sup>1</sup> The NanoStreeM project (Nanomaterials: strategies for safety assessments in advanced integrated circuits manufacturing) receives funding from the European Union's Horizon 2020 Research and Innovation Programme under grant agreement n° 688794.



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# Materials: Nanoscale fabrication and nanoscale characterisation

Nanoscale fabrication and nanoscale characterisation when it comes to materials are placed under the spotlight here by Professor Jakob Birkedal Wagner, Head of Nanocharacterization Section at DTU Nanolab, Technical University of Denmark

Nanoscale fabrication and nanoscale characterisation are entangled to a large degree. Nanofabrication allows for synthesis and formation of tailor-made materials and structures with properties not necessarily found naturally on Earth, bringing value to the society in terms of higher energy efficiency, higher sustainability, increased living standards via advanced tools for medical treatment to name a few.

The fabrication or synthesis of nanostructured materials relies on top-down or bottom-up processes. In order to gain control of such processes, the individual steps have to be closely monitored.

The National Centre for Nano Fabrication and Characterization at the Technical University of Denmark (DTU Nanolab) embraces both the state-of-the-art fabrication of micro- and nanostructures, as well as characterisation of said structures by means of the state-of-the-art electron beam based microscopy and spectroscopy helping to bring the fundamental research into applications.

DTU Nanolab operates and maintains advanced processing equipment within 1350 m<sup>2</sup>, class 10-100, ISO 9001-certified, open access, pay-per-use cleanroom facilities. In a separate specially constructed building, the centre operates eight state-of-the-art

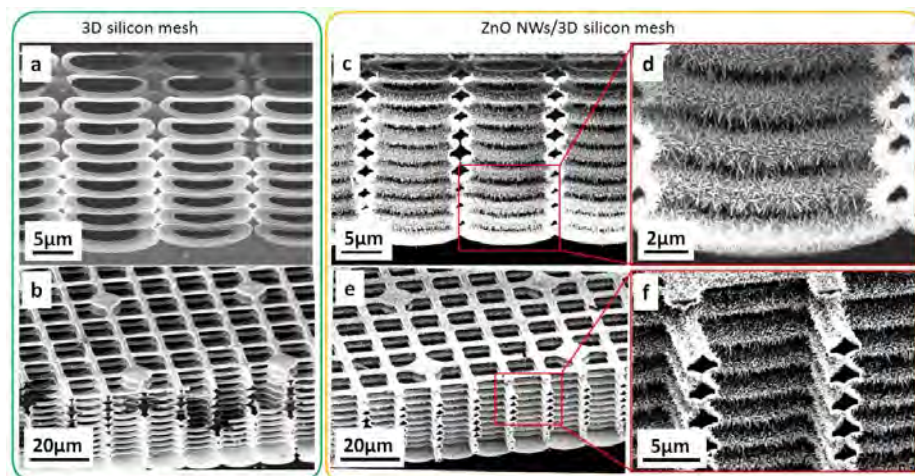


Figure 1: Scanning electron micrographs of ZnO NWs/3D silicon structure. a)-b) 3D silicon structure before the growth of ZnO NWs. c)-f) 3D silicon structures integrated with ZnO NWs, the formed ZnO NWs are approximately 1  $\mu\text{m}$  in length and 60nm in diameter.

electron microscopes, among them four Transmission Electron Microscopes (TEM) and a Dual Beam Scanning Electron Microscope (FIB-SEM).

The fabrication part of DTU Nanolab is built as a versatile micro- and nanofabrication platform in order to shape a wide range of materials with structures down below 20 nanometers on substrates up to 8" in size. This includes a comprehensive and expanding selection of state-of-the-art process equipment for lithography, etching, thermal processing, thin film deposition, wafer cleaning, advanced packaging and characterisation.

The characterisation part of DTU Nanolab has established world-class expertise within material characterisation. Our state-of-the-art equipment allows for high spatial resolution

imaging and spectroscopy at elevated temperature in gaseous environments.

The combined facility has currently around 100 staff members and over 450 registered users, active in research, education, analysis, material characterisation, development, prototyping and small-scale production. DTU Nanolab's scientific staff are pushing the state-of-the-art in characterisation and fabrication by conducting research on new electron beam based microscope techniques and new micro- and nanofabrication technologies. Engineers and technicians repair and maintain the equipment, train and help the various users to achieve their respective goals.

DTU Nanolab is located on DTU's main campus in Lyngby, 15 km north of the centre of Copenhagen, Denmark



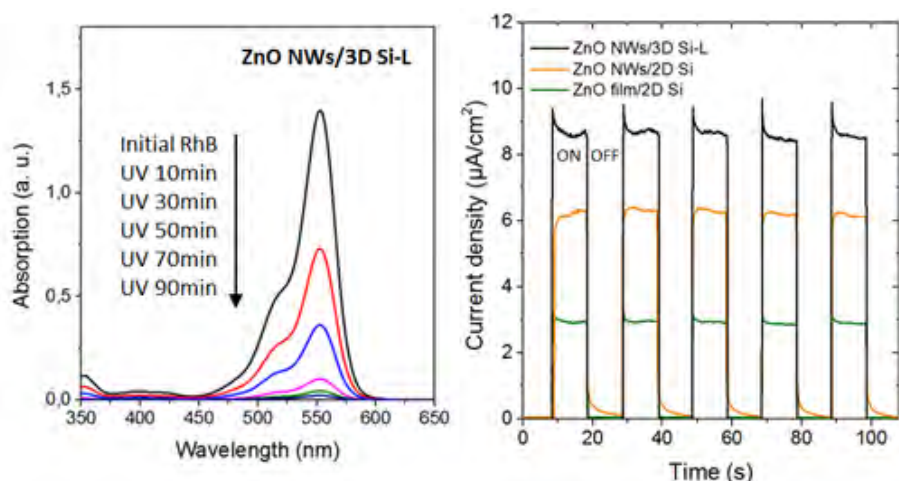


Figure 2: Left: UV-Vis absorption spectra of an aqueous solution of an organic dye (RhB), when ZnO NWs/3D Si is used as photocatalyst for degradation. The decreasing absorption peak of the RhB dye (at 554nm) during extended UV exposure indicates the photocatalytic degradation process. Right: Photocurrent response of ZnO NWs/3D Si structures illuminated by UV light on/off cycles at a bias of 0.5 V vs. saturated calomel electrode.

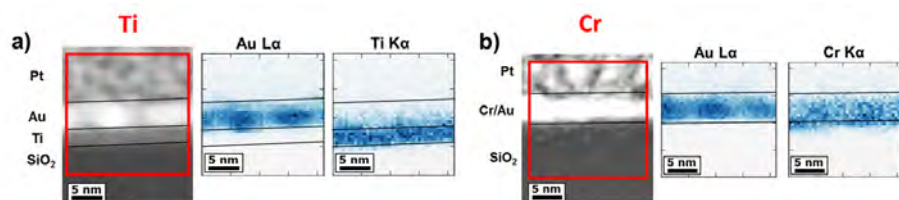


Figure 3: STEM-EDX maps of (a) 2nm-Ti/2nm-Au sample and (b) 2nm-Cr/2nm-Au sample. The elemental maps indicate a strong interdiffusion between the layers in the Cr case opposed to the Ti case.

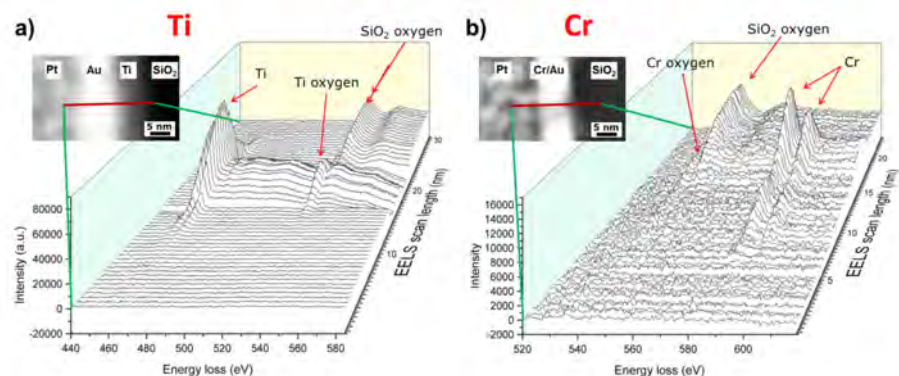


Figure 4: (a) STEM-EELS linear scan of 2nm-Ti/2nm-Au sample, showing the presence of oxygen in the Ti layer. (b) STEM-EELS linear scan of the 2nm-Cr/2nm-Au sample, which shows the presence of oxygen that is bounded to Cr and Cr diffusion into the Au layer.

around 30 minutes from Copenhagen Airport Kastrup.

The integration of low-dimensional nanomaterials with hierarchical three-dimensional microstructures opens up the possibility for the realisation of novel properties or improved func-

tionality. Figure 1 shows an example of such integrated structures. Heavily doped silicon has been fabricated into a highly-ordered 3D micro-mesh structures by standard photolithography, followed by a modified plasma etch process.<sup>1</sup> The density of the integrated ZnO nanowires (NWs) into the

mesh is increased by approximately an order of magnitude in comparison with a more traditional 2D substrate. The performance of photocatalytic degradation and photocurrent generation (Figure 2) scales with the ZnO NW density.

Application of gold thin films within plasmonics, metamaterials, 2D materials and nanoelectronics, relies on efficient adhesion of gold layers on dielectric or semiconductor substrates. Downscaling in nanoscience and technology brings the dimensions of thin metal layers to be similar to adhesion layer implying a strong structured relationship to be explored for efficient application.

Fabrication of such layered structures by e-beam evaporation and close monitoring by means of characterisation at the sub-nanometer scale brings a better understanding of the interdiffusion, as well as the structural behaviour of the evaporated layers<sup>2</sup> (Fig. 3 and 4).

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# Digital transformation in the NHS: Interacting with the emergency services

Salvatore Sinno, Global Chief Security Architect at Unisys speaks to Open Access Government about digital transformation in the NHS, including why Brits are calling for a rapid shake-up in the way they interact with the emergency services

Currently, the emergency services receive millions of calls every year. However, around 30 million calls a year do not follow the usual pattern, with no one speaking on the call – though many are accidental, callers may have intentionally dialled 999 but talking out aloud will put them or someone else in danger. Although ‘[Silent Solutions](#)’ is in place for such circumstances, awareness is low, and the solution isn’t failproof, following numerous high-profile cases.

## A call for change in how Brits interact with the emergency services

Brits are calling for a rapid shake-up in the way they interact with emergency services, the new 2018 Unisys Security Index found.

Over eight in 10 of Brits are calling for an emergency button on their smartphones, enabling them to share their location with the police in times of need. The same number of people are willing to share their tracking and monitoring data from medical devices, to immediately transmit significant changes to their doctors. Despite Brits being more resistant than ever to share data, there is a clear appetite to do so when it’s a matter of life or death.

## Interacting with the emergency services – time for a change?

In this interview, Global Chief Security Architect at Unisys, Salvatore Sinno tells us why Brits are calling for a rapid shake-up in the way they interact with emergency services. He notes that people understand the benefits when it comes to the digital transformation and the value of sharing information and trust.

“A clear flow of data means intelligence and therefore, an improvement in the service provided, so sharing

information with the health service, the police and the emergency services is important. People are now used to accessing services online, such as banking, Facebook and therefore, they expect to be able to interact with the emergency services in the same way.”

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“There is one element across the themes of the 2018 Unisys Security Index which is the control element, in that people are clearly telling us that they want to maintain control over their personal data in terms of how it is shared between organisations and they want to place trust in the emergency services, that is the NHS. This is very good news and we should be proud of this country that people can see the great work that the NHS does in this way.”

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## The integration of technology into the NHS

From a health perspective, the Department of Health and Social Care recently published its policy paper, ‘[The future of healthcare: our vision for digital, data and technology in health and care](#)’, which laid out how tech may be integrated into the NHS, including the widespread adoption of health-tracking apps and wearables. There is a clear demand for this, Salvatore underlines, indeed, this policy will help to improve the quality of healthcare in the future.

“The new element in this policy paper which is important from my point of view is the definition of standards so that the new service provider can be considered as a part of the ecosystem of health solutions. This is very important because it drives in a very clear sense, the public sector, the private sector and innovators to leverage this aspect of digital transformation. Everyone has to agree on that because the way we see our health services is that they are improving and moving towards being world-class by adopting technologies such as artificial



intelligence (AI) as a way to integrate the different communication data flow between the different parts of the services.

“One of the challenges when you define a vision, or a strategy is to make that consequential to ensure that the public sector, the private sectors and the players can action that in a way that is not ambiguous. Part of that is standards – we have a definition of what the API should look like and what kind of integration we want.”

### **Concerns about identity theft**

The conversation then moves to the concerns the 2018 Unisys Security Index™ reveals about identity theft. Salvatore says that the same concern was present for the survey in 2017, but one aspect of the research concerned people's finances in the future, in that identity becomes essential because there is another element at play here, that is lack of control. Salvatore explains more about this in his own words.

“People are concerned about what is happening in their financial space in the future, and the other element is the lack of control and even understanding what can

be done in having a preventative effect, and then respond if you have evidence that identity has been compromised.

“On this point, I think that we can probably do more. By that, I mean the private sector, including corporates such as Unisys, big giants like Facebook in social media and the government can do more to educate people. It comes down to ‘education, education and education’, so it's not that you need to have a super advanced knowledge of security technology but what you do need is common sense – so don't open any email that says you have won a lottery that you haven't even taken part in.

“On the content of such emails, it is difficult to believe that someone can fall for that, but it does happen. The concern is that the most vulnerable people are the ones who fall for this kind of scam, so this is why it is very important that more needs to be done to reassure the people.

“Unisys Security Index 2018 survey suggests that people are now more aware of these issues and they



are concerned: this is a positive element in my view. Another important element emerging from the study is that they no longer use the companies that misuse their personal data. Incidents on websites such as Facebook are no longer acceptable, so people will move their business elsewhere because they know that companies can and must do more to protect personal data.”

### **The UK's appetite for emergency help apps**

The survey notes that an appetite for emergency help apps that are triggered manually by the user or automatically was exceptionally high during 2017. He notes that while we are all interconnected today, people realise that the response time really makes the difference between life and death, therefore, emergency help apps can assist in a number of ways such as identifying your location. Salvatore details this point further, which includes an emphasis on the control element in this vein, he explains.

“There is one element across the themes of the 2018 Unisys Security Index which is the control element, in that people are clearly telling us that they want to maintain control over their personal data in terms of how it is shared between organisations and they want to place trust in the emergency services, that is the NHS. This is very good news and we should be proud of this country that people can see the great work that the NHS does in this way. At the same time, people want to be the ones who press the button and ask for help, but less than 30% were keen for the police to have access when it comes to privacy.

### **Closing thoughts on the 2018 Unisys Security Index**

Salvatore then adds his concluding thoughts on what else the survey reveals, noting that one interesting aspect is that people are concerned about the police or the government having access to their personal data without the individual's consent.

“However, people are less concerned about this when it comes to using social media to post information which can sometimes be quite sensitive. For example, people will say on social media that they are going on

holiday next week and, therefore, their house will be empty. They may say they are in a fantastic restaurant and share a photo of their food, so this is telling the world not only what you do and don't like in terms of food, but you are giving away where you are when you are away from your normal routine.

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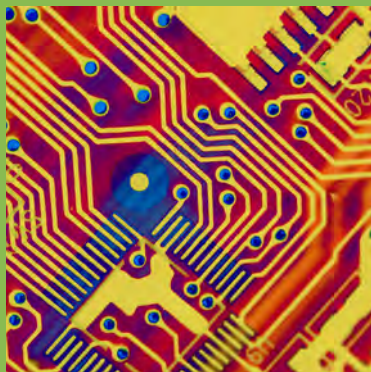
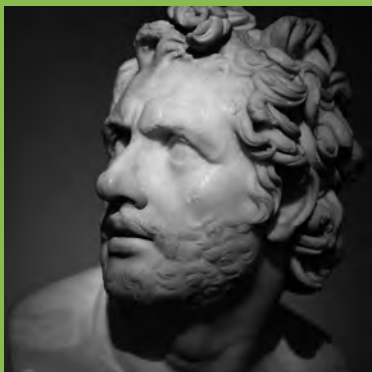
“One of the challenges when you define a vision, or a strategy is to make that consequential to ensure that the public sector, the private sectors and the players can action that in a way that is not ambiguous. Part of that is standards – we have a definition of what the API should look like and what kind of integration we want.”

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“Many people don't realise the amount of information that is freely available on social media and can be collected and analysed. This can create a picture of the individual, so there is a lack of understanding of what can be gathered from social media. The reason for this is that you still feel there is a difference between your digital world and your real life: however, we live in an era when the difference between these is blurring. Identity is central to that because something that is committed online has a long-lasting effect on your financial situation.” ■

**Salvatore Sinno**  
**Global Chief Security Architect**

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# The finances of the European Union, including the research budget

The finances of the European Union, including the research budget is placed under the spotlight by Günther H.Oettinger, Commissioner for Budget & Human Resources at the European Commission

**T**he finances of the European Union differ from those of national administrations in many respects, but what they all have in common is that there is a constant tension between short-term needs and longer-term ambitions. How do we cope with the crises of the moment – perhaps an environmental catastrophe or humanitarian disaster – whilst preparing for the challenges of mid-century: climate change, changing demographics, economies transformed by artificial intelligence (AI)?

## Negotiations for the next multiannual financial framework

One of the EU's mechanisms to reconcile this tension is a seven-year budget cycle that sets the outline for each annual budget. I am currently leading the European Commission's negotiations for the next multiannual financial framework (MFF 2021-27), whilst also ensuring smooth implementation of the annual budgets set in the MFF for 2014-20, which was agreed by the Member States and the European Parliament back in 2013.

We concluded the detailed negotiations on spending in 2019 in December 2018. The budget has been set at €165 billion. Since EU rules do not permit us to run a deficit, the spending limits are balanced by decisions on raising the necessary revenue. The lion's share of that comes from Member States contributions in addition to customs duties and a share of the value-added tax (VAT).

Ahead of the negotiations, I pushed to keep spending on investment and growth at ambitious levels. The broad parameters of the 2019 budget were set back in 2013, so there was only limited scope to make incremental changes. Nevertheless, there are some important trends in this budget which are worth pointing to as they herald a shift in focus which I am confident will become even more marked with the next MFF.

## The research budget

Firstly, I would draw attention to the research budget. The Horizon 2020 programme makes up 7% of the current seven-year framework (and 7% of the 2019 budget too) and is one of the largest research and development funding programmes in the world. We have seen many European success stories in the field of research and technology, but we need to do much more to encourage the creation of start-ups if we want to stay in competition with the U.S. and Silicon Valley. We will be enhancing the European Innovation Council (EIC) pilot initiative in 2019, which currently has €2.7 billion of the Horizon 2020 budget directed towards making this happen. The initiative will test elements of the planned future structure of the EIC under the Horizon Europe proposal to fast-track disruptive and market-creating innovation.

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**“Migration is a high priority in the 2019 budget, as it has been in all EU annual budgets since 2015, but here too there is an important trend, as this funding will increasingly be used to tackle the root causes of migration and to strengthen the EU's borders, rather than being primarily needed for emergency actions in the Member States.”**

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This brings together the parts of Horizon 2020 that support high-risk/high-return, breakthrough research and will experiment with a number of new approaches, consistent with our longer-term drive for more mission-oriented policies. Scientists and researchers will find opportunities for networking, mentoring and coaching, and strategic advice aiming to upgrade the innovation ecosystem in Europe.

European countries will also be able to coordinate their supercomputing strategies and investments together with the European High-Performance Computing





(HPC) Joint Undertaking. The idea was adopted very quickly by both the European Parliament and the Council in autumn 2018, so the joint undertaking will be able to start work in 2019 with a dedicated work programme reflecting Europe's investment priorities for HPC infrastructures and research and innovation.

We expect the work programme to include actions, such as continuing the development of the European microprocessor and exascale systems and of exascale software and applications and co-designing their integration in extreme scale prototypes. The Euro HPC joint undertaking will also contribute to the creation of national HPC Competence Centres, which will stimulate the wider use of HPC and address the specifically HPC-related skills gap.

### **The Facility for Refugees in Turkey**

Another noteworthy aspect of the 2019 budget is the contribution towards the €3 billion which will be spent through the Facility for Refugees in Turkey, to care for and support refugees still fleeing wars and persecution in Syria and elsewhere. Migration is a high priority in

the 2019 budget, as it has been in all EU annual budgets since 2015, but here too there is an important trend, as this funding will increasingly be used to tackle the root causes of migration and to strengthen the EU's borders, rather than being primarily needed for emergency actions in the Member States.

### **Equipping the EU for the longer-term**

My task now is to persuade the Member States to agree on an MFF for 2021-27 that equips the EU for the longer-term. ■

**Günther H. Oettinger**

**Commissioner for Budget & Human Resources**

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# Research on the effects of taxation on the economy, including labour supply

In the first of three articles, Bernd Hayo, Professor at the University of Marburg highlights recent macroeconomic research on the effects of taxation on the economy, including labour supply

This is the first of a series of three articles briefly highlighting recent macroeconomic research on the effects of taxation on the economy. The present article investigates inasmuch taxation has an impact on the labour supply. The second article will study the relationship between consumption and taxation. In the last article, we will take a look at the efficacy of tax changes as an instrument for stabilising the business cycle.

The link between taxation and labour supply is of considerable interest to both academics and policymakers. For instance, labour supply responses to taxation are important for assessing the efficiency loss associated with distortive income taxation. To answer the question as to what extent taxation influences the labour supply, Hayo and Uhl (2015) provide evidence based on a nonstandard methodological approach. Rather than relying on indirect estimates of labour supply based on observable economic data, they use a specifically designed, representative survey of the German population.

In the survey, they directly ask the respondents whether taxation matters for their labour supply decisions and, if so, how they adjusted their labour supply in response to a recent payroll tax change in Germany. Their results indicate that taxation matters for around 41% of the respondents,

implying that the majority is unresponsive to taxation. One implication of this finding is that a significant part of the German population does not react to tax change and that taxation of this non-reacting group should lead to small efficiency losses.

Hayo and Uhl (2015) then use a 2013 payroll tax change to investigate specific labour supply responses to a real-world tax policy change. They discover that 17% of those respondents indicating that taxation is important for their labour supply decision increased, and 12% decreased their labour supply. The labour supply changes can be distinguished into an income and a substitution effect (Keane, 2011). The former refers to the situation that workers achieve a higher net income when the tax rate declines. A higher net income is then supposed to lead to a greater demand for leisure time, i.e. a reduction in the labour supply.

**“Their results indicate that taxation matters for around 41% of the respondents, implying that the majority is unresponsive to taxation.”**

In contrast, the substitution effect refers to the higher net income making it more attractive to work, which should increase the labour supply. Since we find both people increasing and decreasing their labour supply, it suggests that both

income and substitution effects of tax changes are empirically relevant, which is consistent with results reported in Borjas (2005).

Finally, Hayo and Uhl (2015) discover that results do not vary across individuals who believe these tax changes to be either temporary or permanent, which further supports the conclusion that the deadweight loss associated with progressive income taxation is rather small in Germany.

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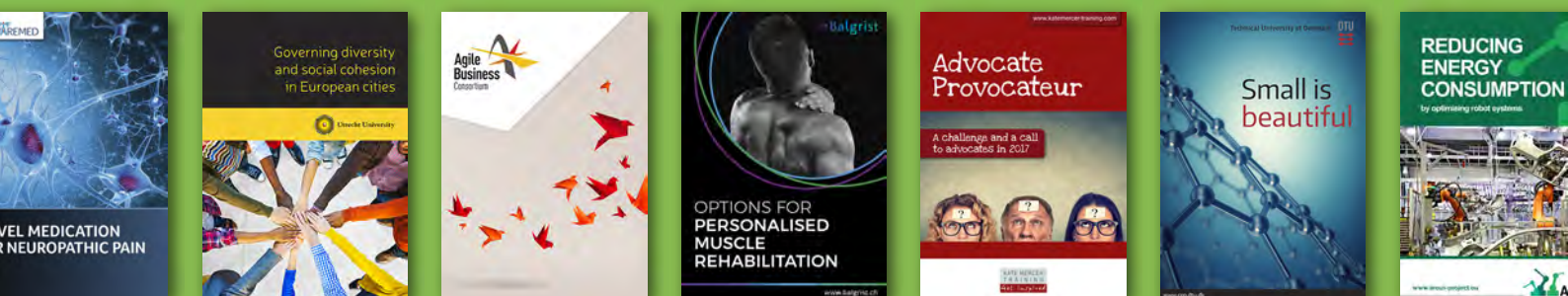
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# The issues at stake for the continuation of the Horizon Europe negotiations

Jan Palmowski, Secretary-General of the Guild of European Research-Intensive Universities details the issues at stake for the continuation of the Horizon Europe negotiations

It took the European Parliament's Committee on Industry, Research and Energy (ITRE) and the Council six months – between June and November 2018 – to develop their respective positions on the Commission's proposal on the main elements of Horizon Europe. For all three EU institutions, this process has been a balancing act between competing objectives: inclusiveness and excellence, research and innovation, securing European interests and opening up to international collaboration. So, what are the issues at stake for the continuation of the Horizon Europe negotiations?

## Excellence or inclusiveness?

Whilst the Parliament and the Council fully endorse the principle of excellence as the cornerstone of Horizon Europe, the question of how this can be squared with the ITRE Committee's push to increase spending on research and innovation in EU13 countries is wide open.

One likely option is that spending on 'Widening Participation', a part of the budget reserved exclusively for the purpose of capacity-building in research and innovation in lower-performing regions, will be increased beyond the Commission's proposed 1.8%. This is a well-justified way of addressing the participation gap without changing the excellence-based selection of projects that have been the carefully safeguarded principle of framework programmes. But Parliament's ambition to further equalise researchers' salaries across Europe looks much harder to achieve.

Ultimately, salaries are a national issue – in some cases salaries are strictly mandated by national governments. It is extremely difficult to see how Parliament's ambition for 'equal pay for equal work' can be realised, though of course, it would be possible to increase the top-up funds that already exist for lower-performing countries.

The toughest negotiations will be around Parliament's demand for increasing participation of EU13 countries as a main objective of the programme. Reducing the gap may be desirable for all sorts of reasons, but it cannot be a core objective: the objective must remain funding the best science and innovation, irrespective of where it comes from.

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**“The Commission’s drive to prioritise innovation has luckily been balanced with the Parliament and the Council’s explicit support for research at low technology readiness levels, which is urgently needed to guarantee opportunities for research collaboration and knowledge production in areas considered priorities for Europe. In short, the balance between fundamental research, applied research and innovation, will be a key issue during the trilogues.”**

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## Questions of content

Both the Parliament and the Council have backed proposals to strengthen programmatic support for the Arts, Humanities, and Social Sciences (SSH). They proposed the creation of a separate cluster focusing on culture and society within the, second, challenge-led pillar, and called for mainstreaming SSH across the technologically-oriented clusters.

At the same time, there is a greater focus in Horizon Europe on new technologies and the application of results. The Commission has been clear that it is particularly concerned about boosting the EU's capacity for innovation, as Europe lags behind the U.S. and Asia in translating new discoveries into innovative products. The second pillar thus focuses, to a significant extent, on enabling Europe to develop world-leading capacities in future technologies, such as artificial intelligence (AI) and deep-tech. Moreover, the programme's third pillar will lend significant support to innovation, with the

European Innovation Council (EIC) and the European Institute of Technology (EIT).

The Commission's drive to prioritise innovation has luckily been balanced with the Parliament and the Council's explicit support for research at low technology readiness levels, which is urgently needed to guarantee opportunities for research collaboration and knowledge production in areas considered priorities for Europe. In short, the balance between fundamental research, applied research and innovation, will be a key issue during the trilogues.

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**“Ultimately, salaries are a national issue – in some cases salaries are strictly mandated by national governments. It is extremely difficult to see how Parliament's ambition for ‘equal pay for equal work’ can be realised, though of course, it would be possible to increase the top-up funds that already exist for lower-performing countries.”**

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### Who decides?

A major innovation of the Commission's Horizon Europe proposal lies in producing a more flexible framework for research and innovation that could be adjusted over the course of seven years. This means that beneficiaries can expect more political control over the research topics in the course of the programme. However, the strategic planning process would invite stakeholders and citizens in a process of co-creation together with decisionmakers to set strategic priorities for the second pillar. But this has raised difficult questions. An important concern has been the question of how citizens would be asked, and what the status of this input would be, as well as how it would relate to the input of governments and the Parliament.

Moreover, representatives of the science community – The Guild of European Research-Intensive Universities included – have raised their concerns that the voice of scientists would get diluted even further, with potentially serious consequences for the scientific quality of a

framework programme and its ability to address urgent research topics that rely on European collaboration.

### Europe must act

It is hardly surprising that many of the most controversial issues of Horizon Europe concern those elements that are new, such as the remit of the European Innovation Council, Strategic Programming, or the nature of the Missions. And these substantive disagreements do not even take into account the budget – neither the overall budget for Horizon Europe, nor how much will be spent on individual instruments: this will not be decided until the very end, when the overall financial envelope of the EU budget has been agreed. Negotiations about these issues will be complicated by the elections to the European Parliament in May 2019, and the subsequent appointment of new commissioners. The arrival of new actors in Parliament and in the Commission, some of whom may have little experience in research and innovation, makes it imperative that as much progress as possible is made in negotiations about Horizon Europe by Easter. We need these negotiations to be successful for the sake of creating an internationally competitive framework programme for research and innovation that can truly respond to the societal challenges of our time. And policymakers need to demonstrate that Europe can act decisively, that the EU can make a positive difference to the everyday concerns of citizens. ■

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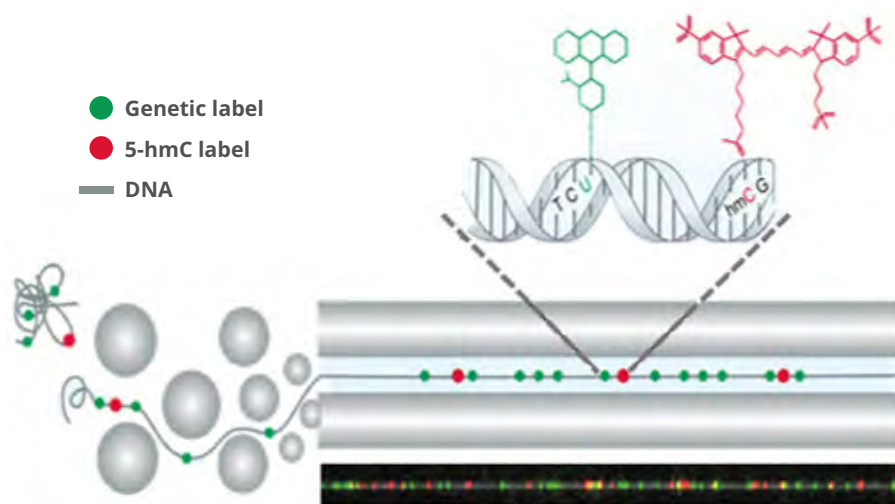
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# Interdisciplinary research: New technologies for studying genomes

The Ebenstein lab for NanoBioPhotonics in Tel Aviv University, Israel, develops new technologies for studying genomes, an aspect of interdisciplinary research that Prof Yuval highlights here

The DNA sequence is identical in almost all cells in our body, however, each cell or tissue has a unique gene expression profile and consequently different function. These differences are a result of epigenetic mechanisms. Epigenetic marks are small chemical modifications attached to the DNA or to proteins that wrap the DNA. These modifications determine which genes will be expressed and which will be shut down. The global levels and genomic patterns of epigenetic marks are altered in many types of diseases, including cancer. These changes can be monitored and may potentially be used as biomarkers for detection and diagnosis of diseases.

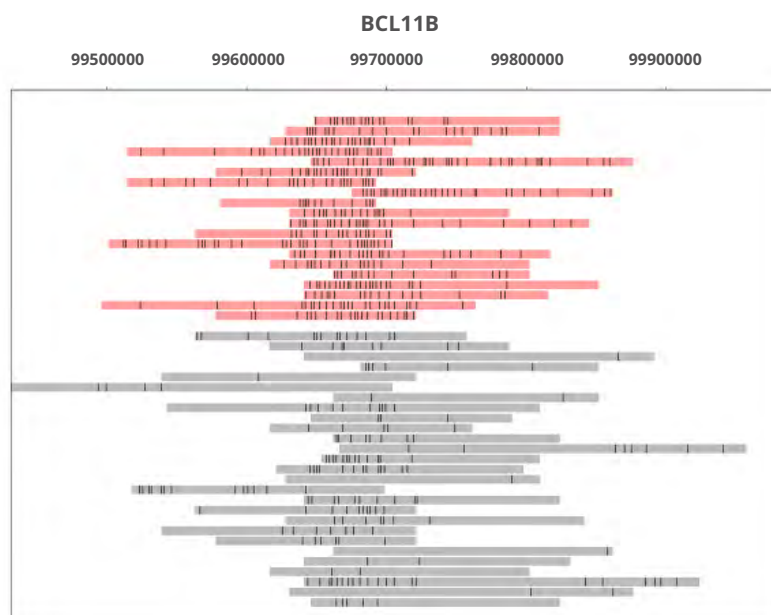
In our lab, we develop methods for labelling epigenetic marks by tagging them with a fluorescent molecule. We also label a specific genomic sequence with a different colour to generate a barcode, which helps us track the genomic location that each molecule originated from. The molecules are then stretched by squeezing them into nanochannels and imaged by a unique microscope. This process results in long DNA fibres, decorated with two colours, which can be aligned to the genome and create a map of the epigenetic marks (see figure). Since we are looking at single DNA molecules, each molecule originated from a single cell, we can study variations between cells and discover rare populations that are masked by most methods.



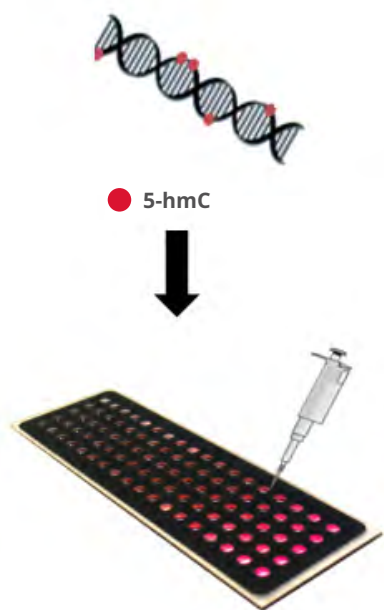
## Hila Sharim, PhD student

In my study, I focus on the epigenetic mark 5-hydroxymethylcytosine, or 5-hmC, which was discovered in mammals less than ten years ago and its roles are not fully resolved. My goal is to use the optical detection methods developed in our lab to break up mix-

tures of cells into the subpopulations comprising them. Specifically, by fluorescently tagging 5-hmC, which is associated with gene expression levels in each cell, we can build a model to differentiate the specific epigenetic patterns, consequently identify each cell type.







The figure presents a collection of single DNA molecules from a mixture of cells, all originating from the same genomic location. The black dots represent the detected epigenetic marks on each molecule. The molecules in the figure have been divided into two groups based on the density of their epigenetic pattern, one group shown in red and the other in grey. This division corresponds to the presence of two distinct subpopulations of cells in the mixture. The identification of unique patterns in a mixed population may be especially important for cancer diagnosis, where detecting a small subset of cells displaying irregular patterns may assist in early detection of the disease.

Since the human genome is composed of more than three billion bases, mapping the entire genome can be very expensive, especially if we want to focus our analysis in a specific region of interest. Therefore, we have developed a method for targeted enrichment of long DNA fragments, called CATCH, which utilises guided CRISPR/Cas9. Using this method, we can isolate genomic targets of up to 1-2

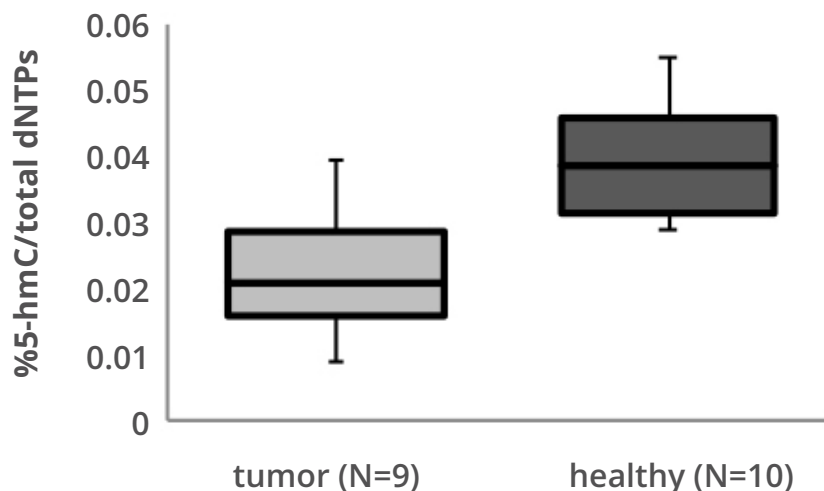
million bases, and still keep the DNA molecules intact with its epigenetic marks. Using this technique, we were able to isolate the breast cancer associated- BRCA1 gene with more than 200 -fold enrichment, and specifically analyse this fragment, without wasting money and resources on undesired genomic regions.

#### Sapir Margalit, PhD student

In my study, the aim is to harness epigenetic marks to develop new, easy and accessible tools for diagnosing diseases, with an emphasis on cancer. The global level of the epigenetic DNA modification 5-hydroxymethylcytosine (5-hmC) is known to significantly decrease in many cancers, and therefore, its measurement can be utilised for detection, and potentially even for prediction, of these cancers. The assay that we have developed involves sensitive fluorescent tagging and optical visualisation of this modification and can accommodate many different samples at once, providing a fast and robust analysis.

Our results indicate that this assay allows distinguishing between a

#### %5-hmC in colon samples



healthy and cancerous colon and brain tissues based on their 5-hmC content and complement the current diagnosis workflow. Other appealing applications are detecting low 5-hmC levels present in blood, potentially enabling cancer detection using a simple blood test, and monitoring patients' response to a given treatment at frequent intervals for personalised therapeutic decisions.

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# Making Europe great again in research and development

Dr Jean-Claude Worms, Chief Executive, European Science Foundation (ESF) explains how research and development (R&D) will make Europe great – again

For a scientist, the notion that any given country – or continent – should rise above the others is irrelevant at best. Science is global – it cannot accommodate borders any more than an astronaut orbiting the Earth cannot see them while hovering over a seemingly unified planet. Science critically depends upon freedom of exchange and cooperation is its natural language. Naturally competition amongst researchers for fundamental or applied breakthroughs – who publishes first, somewhat sobers this idyllic view.

When it comes to innovation, however, the picture tends to change significantly. Short-term economic imperatives (job creation) and the lure of immediate applications are core reasons to invest significantly or not in research, regardless of the documented fact that continuous investment in basic research fuels economic growth. South Korea invests 4.2% of its GDP in research and development (R&D), twice as much as 2006, while the average rate for the EU has been stagnating at around 2% for 10 years. To change that trend, I believe that science stakeholders have a duty to inform and guide decision-makers in their choices and that duty comes with the critical need to be intelligible and didactic, not dogmatic.

So why should Europe invest much more than it currently does? Why should it become great – again – in R&D? For these two reasons highlighted above. Because science raises civilisation to higher pinnacles of achievement, education, understanding, and mastery of our environment and of future challenges. Also, because it is a well-established fact that investing in R&D allows countries to reap the benefits of those investments through higher growth, innovation, better economic performance and job creation. Only by raising our involvement in science will we be able to, both, tackle major challenges and deliver economic growth.



*Dr Jean-Claude Worms, Chief Executive*

Admittedly, combining the two goals is a subtle exercise. Basic research requires transparency, openness and free exchange of ideas and concepts. Innovation and applications require IPR regulations and a much more competitive approach. The challenge is to be able to pursue these two goals in parallel, without being political naïve while not impeding the work of scientists.

## Landscape

Since the creation of the European Research Council by the European Commission in 2007, Europe appears to gradually fill the very large funding gap left by the

demise of the cross-border collaborative research instruments managed by the European Science Foundation, in particular, through its “Synergy Grant” scheme. Most of the other ERC instruments fund individual scientists, while these grants support coordinated work between teams, enabling the consolidation of European research. We have still not fully caught up with the past situation, but this is clearly pointing in the right direction. Another interesting aspect of ERC’s work is their “Proof of Concept” scheme, supporting researchers to bring their research ideas closer to market applications. Europe is notoriously bad at this, at least when compared to the U.S. or South Korea, so this initiative is laudable and should be encouraged.

### Framework

Clearly, funding bottom-up research proposals is in line with providing appropriate support to basic research. The other angle addressed above should also be supported adequately.

In that sense, the “Missions” approach proposed by Marianna Mazzucato and introduced by the European Commission as a central tool in the architecture of its next Framework Programme, Horizon Europe, represents a very interesting element in the current debate.

Such missions are already called ‘Moonshots’ by some to reminisce about the U.S. Apollo initiative although it can be doubted that they will be funded at the level of €24 billion – it seems that some 10 missions could have been identified and would be funded at approximately €1 billion each over ten years.

Regardless, very large missions have the potential to introduce specific goals in the EU policy framework for R&D&I. However, a cautious approach needs to be taken to ensure that we don’t throw away the baby with the bathwater, i.e. that this new and yet untested approach does not wipe out the funding for the rest of the research-related parts of the FP. Several important questions remain to be discussed, such as, what share of the FP will these missions get and how will they be connected to existing instruments? How will they be

selected and managed throughout the period? It seems urgent to design a mix of approaches whereby a limited number of such missions would be tested first, in a carefully phased approach during the period 2021-2027.

### Open Science

On this burning topic, people will most probably have heard of the initiatives ‘Plan S’ and ‘cOAlition S’ regarding open access policy. Launched by the EU Open Access Envoy and further developed by Science Europe, they are now endorsed by several of their member organisations. Key to this discussion is how can Europe enforce a policy by which publishers would change their business model from the current ‘pay-to-read’ into ‘pay-to-publish’, largely reducing the huge cost incurred by research funders worldwide. Apparently, €8.5 billion are paid annually by libraries to publishers just to read (their) research. Money is in the wrong place and a simple transfer by the publishers on their accounting books (royalties to publication fees) would naturally not be the solution.

How can this be solved? Would simply substituting the ‘pay-to-read’ with the ‘pay-to-write’ models not amplify the risk of development of low-quality journals and publications? Furthermore, and as mentioned at the beginning of this article, transparency and open access are good in principle for science, but similarly, a totally open access policy might hinder European innovation. Clearly many aspects concerning open access are still unclear and need to be thought through carefully. The European Science Foundation will be happy to contribute to these debates. ■

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# Engineer or researcher? Spot the difference!

Julien Scheibert & Alain Le Bot, researchers at CNRS/Ecole Centrale de Lyon share their thoughts on the respective roles of engineers and researchers

**Y**our daughter claims, when it is not her prima-ballerina-day, that she would like to become a scientist? Very well, at the Ministry of Education, they will congratulate themselves that their campaign for gender equality in science is a true success! But has your daughter a clear idea of the type of scientist she is dreaming of becoming? Is she imagining herself as a teacher in high school? As a researcher at the University? As an engineer at the European Space Agency?

All of them will share similar educational trajectories, rooted in a background of exact sciences. They will also share everyday working tools including mathematics, statistics and rigorous reasoning. But what are their fundamental differences? Is there a clear way to categorise those three activities? The question is not as simple as it may seem, as many individuals will actually act as one or the other during the same working day: University professors are expected to both teach and research; the French CNRS hires “research engineers”; expert engineers in industry often serve as trainers in

or outside their own company.

While teaching clearly refers to the transmission of some already established knowledge, be it fundamental or applied, the research and engineering activities are much subtler to disentangle. And research institutions themselves perpetuate the confusion: many of them feature research departments entitled “mechanical engineering” or “electrical engineering”, suggesting that there may exist an engineering science, separate from natural sciences like physics, chemistry or biology.

In our opinion, such a distinction between sciences is irrelevant and the difference between engineers and researchers is rather in their objectives. Both are dealing with challenging the limits of the state-of-the-art. However, while the goal of researchers is to understand reality, that of engineers is to master it. Research is about pushing the boundaries of knowledge, whereas engineering is about increasing our capacity to act on our environment.



economic activities. For instance, engineers do master the many industrial processes involving powders and grains, although researchers still struggle to understand the physics of granular matter. In contrast, researchers had predicted gravitational waves well before engineers managed to detect them. In practice, the research and engineering activities cross-fertilise, so that any scientist should keep a constant eye on the progress made by both communities.

The research/engineering distinction can also help to clarify some human resources issues, both in the industry and at the academy level. Companies constantly face new scientific problems and wonder which type of collaborator they should recruit. Some of those problems only require a robust solution, and engineers are the best suited to identify them. Some others reveal challenges that are deeply related to the core business of the company. In such cases, a general understanding of the problem is desired, because the future of the competitiveness of the company is at stake. This is when researchers are required.

As for public research institutions, some of them should be prouder of their basic research mission. In particular, they should prevent their laboratories from becoming some sort of externalised R&D departments of the industry, solving their engineering problems on public money. Only if the specific necessity of basic research is recognised, will our children have, in the coming decades, the full choice of the type of scientist they really want to become. ■

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To illustrate the difference, let us consider a currently unsolved societal question. How to improve mobility in major cities? A researcher's answer could be to increase the research effort to understand the interactions between the various users of the public space, pedestrians, bikes, cars, trains... to identify suitable circulation rules and routes networks. In contrast, an engineer's answer could be to exploit the big data available from, for instance, video surveillance, city tolls, or parking time stamps, to find which circulation plan has, statistically speaking, offered the best results so far and generalise it. Clearly, the second solution may bring an efficient answer without any additional understanding of the origin of traffic jams.

### **Cross-fertilisation**

Now that the research and engineering approaches have been distinguished, let us note that it is a common but wrong idea that great advances always start from a fundamental discovery, become an applied research topic and finally feed industrial and

# The priorities for science and research policy in Germany

The wide-ranging work of Anja Karliczek, Federal Minister of Education and Research in Germany is examined here. With a focus on Horizon 2020 and biodiversity, we find out that these two excellent examples of science and research policy take us beyond the borders of the country

This article will look at the wide-ranging work of Anja Karliczek, who became Federal Minister of Education and Research and a Member of the German government of Federal Chancellor Angela Merkel during March 2018. We'll also look at the Federal Ministry of Education and Research's (BMBF's) views on Germany's role in Horizon 2020 and their policies around biodiversity in the country. Before we do this, let's take a look at Anja Karliczek's career background. She was born in Ibbenbüren, in North Rhine-Westphalia, Germany on 29th April 1971.

## Political career and academic background

Looking at Anja Karliczek's political career and academic background, we know this included her time training and working for Deutsche Bank AG, as well as training in hotel management, where she gained qualifications to train apprentices. She also worked in a managerial position at the Hotel Teutoburger Wald in the 1990's until becoming a Member of the German Federal Parliament (Bundestag) five years ago, in 2013.

Looking at her academic background, it's worth noting here that she studied business management at the FernUniversität Hagen in 2008, gaining a diploma thesis, which concerned the fiscal advantages of transferring pension obligations from the perspective of the employer.

Anja Karliczek's parliamentary background is rather interesting to look at, so let's take a look at some of this before getting up-to-date with some of the present day objectives of the Federal Ministry of Education and Research (BMBF). Parliamentary Secretary of the CDU/CSU Parliamentary Group was a position she was

elected to in January 2017. Anja Karliczek was a Full Member of the Tourism Committee from October 2013 to January 2017 and also Deputy Member of the Budget Committee and the 4th Committee of Inquiry.

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**“One example of the many areas of research supported by the Federal Ministry of Education and Research is biodiversity. In light of the fact that the continuous loss of biodiversity is certainly a challenge for science, politics and society, the Ministry funds many research projects that set out to preserve Germany's biodiversity.”**

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We noted earlier Anja Karliczek's experience in hotel management. More recently, in the areas of tourism, she was responsible for initial and continuing training in the hotel and catering sector, the EU funding period 2014-2020 and quality initiatives in the German tourist industry. In addition, she was the Parliamentary Group's rapporteur on the Finance Committee for the subjects of old age provision, the Life Insurance Reform Act and Solvency II with the Investment Directive, as well as employee shareholding.

Anja Karliczek's political career began in 2004 when she was elected as Member of Tecklenburg Town Council. She held the position here as Chair of the Lengerich Adult Education Centre Association and Chair of the Committee for Families, Senior Citizens and Social Affairs.

Deputy Chair of the CDU political group on Tecklenburg Town Council in 2009 is another position she held, plus it's worth noting that between 2011 and 2014, she became the leader of the Tecklenburg CDU political



group and took over as Chair of the Tecklenburg CDU Association. Today, she still holds this latter office. <sup>(1)</sup>

## Horizon 2020 – The European Research Framework Programme

One key research policy supported by the Federal Ministry of Education and Research (BMBF) is the new “Horizon 2020” framework programme which aims to create viable jobs and sustainable growth in Europe. In the Ministry’s view, research and innovation are a priority in Europe, as well as being a matter of great interest in Germany and an important part of European integration.

Horizon 2020 is giving funding in the region of €70 billion between 2014 to 2020, the activities of which encompass the entire innovation chain – from basic research to the provision of marketable services and products. The programme targets research institutions, higher education institutions, companies (especially SMEs) plus stakeholders in the wider innovation sector. We know that Horizon 2020 will support the pursuit of excellence of science in Europe, develop solutions to great societal challenges and expand the role of European industry. <sup>(2)</sup>

## Biodiversity

One example of the many areas of research supported by the Federal Ministry of Education and Research is biodiversity. In light of the fact that the continuous loss of biodiversity is certainly a challenge for science, politics and society, the Ministry funds many research projects that set out to preserve Germany’s biodiversity.

We know that biodiversity is an important foundation for human existence in Germany and elsewhere. This is because it provides food, important medicinal ingredients, medicinal plants and natural substances (for building, clothing and raw materials), as well as so-called ecosystem services, including climate regulation. It also offers protection from flooding and contributes to the provision of (drinking) water.

The loss of biodiversity is apparent in Germany, indeed, a quarter of all plant species and a third of all animal species are considered to be endangered. Under the banner of the “National Strategy for Biodiversity” (NBS), the BMBF, in partnership with the

German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) is funding research and implementation measures, which aim to halt the loss of biodiversity in the country and reverse the trend by 2020.

It’s worth noting here that in BMBF’s view, preserving biodiversity is comparable to the challenge that climate change presents, in that both developments are closely linked in terms of impact and cause. BMBF believes that global themes of this scale cannot be tackled in the context of national borders alone. For this reason, the BMBF has made the internationalisation of science and research one of the goals for their research funding. A joint search for solutions to tackle issues such as biodiversity and climate must take place across national borders. This policy is explained further in the quote below from the Ministry’s website, which details how biodiversity loss can be halted through the power of collaborative research, which ends this article on a positive note.

“The success of these research projects is dependent on cooperation between natural, economic, and social sciences as well as close cooperation with other stakeholders. For this reason the research projects, whether national or international, are being developed jointly with decision makers and other players in the target areas. This will allow the development of strategies and utilisation concepts that aim to realise the sustainable use of biological diversity.” <sup>(3)</sup>

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# Molecular Psychology: A modern research endeavour

Dr Christian Montag, Professor at Ulm University and Paul Dagum, MD PhD, Founder and CEO of Mindstrong Health explain the modern research endeavour of Molecular Psychology. Here, they both detail their thoughts on studying individual differences in emotional and cognitive functions of the human mind by combining molecular genetics and smartphone technologies

**M**olecular Psychology represents a modern research endeavour which developed on the background of results from heritability research and related fields of psychological science. Abundant twin research yielded evidence that both nature and nurture are of high relevance to understanding both individual differences in emotionality and cognitive functions. Moreover, both nature and nurture cannot be seen as being distinct entities, because they act upon each other in a dynamic interplay. With the upcoming of fascinating neuroscientific technologies, the discipline of Molecular Psychology aims to disentangle both the molecular genetics and epigenetic underpinnings of (rather stable) individual differences in emotional and cognitive functions.

A better understanding of the molecular mechanisms underlying human individuality is of high interest beyond satisfying human curiosity because individual differences in psychological traits, such as personality are linked to a wide range of important life variables including health behaviour, longevity and the likelihood to suffer from affective disorders. Aside from this, studying the molecular basis of cognition in healthy participants will give valuable insights into the proper functioning of the human mind, which

is also of relevance to understanding the cognitive decline in devastating human conditions, such as Alzheimer's disease. Both affective disorders and dementia represent a huge financial burden for societies around the globe and inflict pain for both patients and their caring families.

Although the discipline of Molecular Psychology is still young, some progress has been made with the result of a few genetic variants being robustly linked to psychological traits, such as neuroticism. That said, it is also true that many results from genetic association studies in the field of psychology and psychiatry do not replicate well and have hampered the progress in this research area.

Recent research endeavours observed that the study of extremely large sample sizes going in the hundreds of thousands in terms of participants applying so-called genome-wide association studies enhance the likelihood of producing robust outcomes. Added to this, candidate gene approaches to investigate smaller samples might also lead to valid results, but chances of producing valid findings will only rise if researchers find genetic associations with a certain psychological trait across independent samples, best stemming from different cultures.

Another approach to increasing the power of statistical testing in such candidate gene studies can be achieved by a priori genotyping. This means that persons are invited according to their genotype to a study (after establishing genetic databanks), with the aim of having the same cell sizes in each experimental group.

Beyond this, the past has seen that many investigators applied their own "favourite" self-report or neuropsychological test batteries to assess psychological traits. This again limits the comparability of results across studies. Here, in particular tracking of real-world-behaviour might help to overcome this problem. Moreover, directly recorded behaviour might give more unbiased insights into a person's lifestyle and behaviour.

## **Digital phenotyping as a new window to understanding psychopathology**

In the last years, a growing number of researchers started to explore the possibilities of digital phenotyping to improve diagnosis in psychiatry. In principle, all traces recorded from human interaction with the Internet of Things (IoT) can be used to get insights into a person's cognitive and psychological condition. One of the most prominent devices with the



Dr Christian Montag

tremendous potential to be studied currently, without doubt, is the smartphone. This is because of its many inbuilt sensors, recent research demonstrating that touchscreen interactions are predictive of clinically significant changes in cognition and mood, and the fact that currently, 2.5 billion humans interact with a smartphone on a daily basis. Such data can aid the psycho-therapeutical process. Finally, cognitive functions might also co-vary with smartphone usage patterns. Persons in the transit zone from mild cognitive impairment to Alzheimer's disease might be characterised by measured changes in touchscreen interactions and a shrinking word pool in daily online communication.

The potential for digital phenotyping to improve healthcare is tremendous. We seek to demonstrate that certain smartphone and in general IoT variables not "only" covary with psychological variables but also to their underlying neuropathology. Finally, digital phenotyping should be considered as protected health information and as such, to only be used in clinical settings where it can be regulated by health privacy policies.



Paul Dagum

## Christian Montag's Molecular Psychology lab teams up with Paul Dagum's Mindstrong Health

Prof Dr Christian Montag's lab at Ulm University (Ulm, Germany) published in 2017's research on molecular genetic markers underlying individual differences in areas – such as autistic traits derived via self-report – but also demonstrated the feasibility of linking biological markers to real-world behaviour as tracked via smartphones. During 2017, Montag's group provided the first evidence that lower gray matter volumes of the nucleus accumbens (part of the brain's reward circuitry) as assessed via MRI scans are linked to a longer and higher frequent use of the Facebook application on smartphones. Aside from this, new work of Montag's group proved that molecular genetic markers, here a genetic variant of the oxytocin receptor gene, can be linked to real-world variables tracked via the smartphone.

Mindstrong Health is a Silicon Valley healthcare technology company founded by Paul Dagum, MD PhD. His team, including president Dr Tom Insel, former director of the NIMH,

who went on to lead the mental health team at Verily, developed a smartphone application which links human-smartphone-interaction patterns to psychopathological states. The ultimate goal of this smartphone application is to improve early detection and pre-emptive intervention in the areas of both psychiatric and neurodegenerative disorders.

Both Montag and Dagum are convinced that the fusion of bio- and med-tech can demonstrate that digital phenotyping provides deep insights into neuropsychiatric conditions.



mindstrong



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# Functional metagenomics: Keys to modern biotechnology, new drugs and much more

Professor Wolfgang Streit from the University of Hamburg details how functional metagenomics applies to modern biotechnology, new drugs and much more

Life on earth is dominated by prokaryotic microorganisms (bacteria and archaea) and it is estimated that more than  $10^{30}$  microbial cells are living on our planet<sup>1</sup>. They harbour a sheer unlimited number of genes encoding a tremendous and unseen metabolic and catabolic potential. The richness and diversity in the genes of all microbes are by far much higher than those of all plants, animals or human genomes together. A recent study estimated the global soil metagenome to harbour at least 160 million soil specific genes<sup>2</sup> and for the marine system, a comparable number of roughly 111 million specific genes was estimated<sup>3</sup>. Because of the incredibly huge prokaryotic biomass, their global importance for all major biogeochemical cycles, their impact on production of climate-relevant gasses such methane or CO<sub>2</sub>, their well-known roles in infection, pathogenicity, symbiotic interactions and their occurrence in all microbiomes there is a very vigorous and permanent interest in understanding the functions of genes and individual microbes in their habitats.

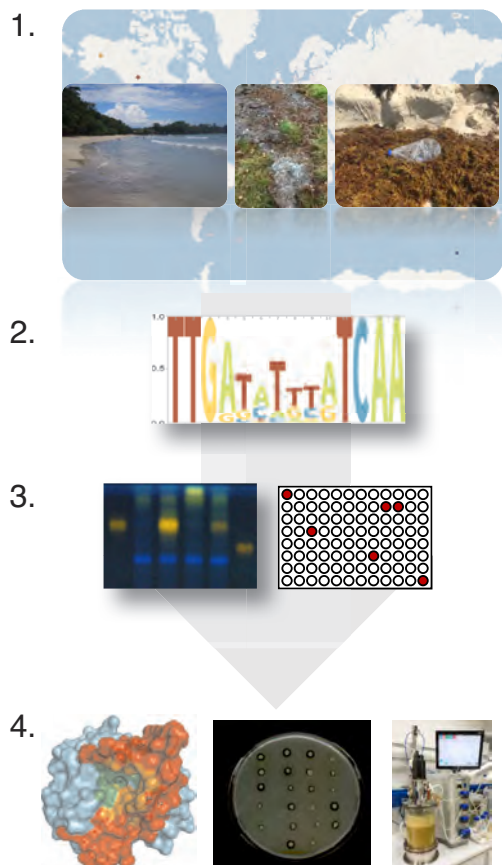
Furthermore and because of their truly high metabolic diversity microorganisms are a very attractive and promising resource for the identification of novel biocatalysts, urgently needed antibiotics, anti-cancer drugs and other valuable biomolecules. In fact, microorganisms code for the blueprints of many innovative products and novel sustainable processes in their genomes

and they offer solutions to some of the most pressing environmental and societal problems we are currently facing (e.g. plastic pollution, lack of environmentally friendly pesticides, and no new antibiotics in sight). In other words, marine and terrestrial microbial resources offer the keys and answers to future biotechnology processes and societal questions.

It is, however, not easy to unleash this vast potential and access these microbes. Mainly two reasons hinder us currently from using this immense potential and deciphering microbial genes and functions on a global scale. First, only less than 1% of all microbes can be cultivated with traditional but also highly sophisticated methods. Thus, the vast majority (>99%) of all microbes remains untouched with respect to their functional roles in ecology and/or their use for biotechnology or any other application. Second, we have a large gap in knowledge on the functions of genes. A large fraction (>50%) of all genes encoded in the global metagenomes and genomes of individual microbes is unknown with respect to their function and even more importantly, many genes have not yet been identified. We call this large fraction of unknown genes 'dark matter' and we are only slowly beginning to develop methods to address these problems.

Functional metagenomics is the key technology that offers solutions to

these challenges. First, it offers a solution for the poor cultivation rates and second, while permitting access to the non-cultivated microbial diversity, it assigns functions to hitherto unknown genes, enzymes and metabolic pathways and it allows identifying novel protein families with novel functions. Functional metagenomics develops and uses methods to exploit microbial communities or single microorganisms without the need to cultivate them. Thereby, this groundbreaking technology exploits the DNAs, RNAs, the proteomes and metabolomes of the globally distributed microorganisms. This is mostly done by extracting samples directly from nature and then analysing these using an array of modern 'omics' and analytical tools and technologies including next-generation sequencing, metabolomics, proteomics, bioinformatic approaches, structural biology and others. During the onset of this research, this was achieved by focusing on a single sample or just a few samples obtained from a confined source. Thanks to the setup of global databases today, this can be accomplished on a global level by accessing the respective databases such as NCBI, IMG or MGRAST data repositories. Thereby, very often, novel globally important organisms, new genes coding for novel enzyme families, complete pathways for antimicrobials or other drugs are identified. Notably, during this process very often, functions are assigned to genes being part of the dark matter.



**Figure 1:** A typical workflow showing the essential steps from the sampling of the global metagenome to discovery of knowledge urgently needed biomolecules and innovative processes. (1) global sampling, (2) extraction of DNA, RNA and other omics (3) Functional assays and biochemical (4) characterisation of novel proteins, antimicrobials, process development and others.

Functional metagenomics is a very modern key technology enabling the development of novel biotechnological and pharmaceutical products. Since the term ‘metagenome’ was coined more than two decades ago, it has resulted in the rapid identification of many thousands of novel biomolecules and biocatalysts with potential value to many bioindustries for the development of more sustainable products. This includes robust and versatile enzymes for food, feed, and textile industries, paper production, fine and bulk chemicals and cosmetic production. By delivering such a wealth of novel biocatalysts, the technology has

led to a much better understanding of the evolution, the structure and the function of biocatalysts and this knowledge have advanced our efforts to identify novel biocatalysts significantly. Thereby, it has further helped us to rapidly integrate enzymes in the novel production process.

**“Functional metagenomics is a very modern key technology enabling the development of novel biotechnological and pharmaceutical products.”**

Functional metagenomics has given us the first clues to pressing societal problems. For example, the removal of plastics from the environment is an urgent problem that if not solved will have a severe impact on our food and feed chain and our well-being. Using functional metagenomics, we have recently identified hundreds of novel enzymes involved in PET degradation<sup>4</sup>. This is a major breakthrough using functional metagenomics and with respect to environmental pollution.

The technology has also given us access to novel antibiotics or other drug molecules with new and or improved traits. It strongly advances the speed of natural product discovery and at the same time, it allows the identification of completely novel structures. For instance, recently Iqbal and colleagues identified a novel antimicrobial compound designated metatricycloene<sup>5</sup>. This compound was identified through the mining of over 1.2 Mio clones and it represents the first example of a new class of antibiotics identified using functional metagenomics.

Besides the above-listed examples, functional metagenomics has further provided recent discoveries on the physiology of non-cultured microbes

and their significance for global biogeochemical processes and it has significantly increased our knowledge on host-microbiota interactions, infection and pathogenicity.

Thus, in summary, functional metagenomics is a very modern key technology driving the discovery of knowledge for basic research and advancing the identification of novel protein families, biocatalysts and other valuable biomolecules. Thereby, providing access to innovative bioprocesses leading to the development of novel drug molecules and helps to provide a solution to some of the environmental and societal needs.

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# How supporting social and behavioural science improves the quality of life

Dr Arthur Lupia, Assistant Director, Directorate for Social, Behavioral, and Economic Sciences (SBE) at the National Science Foundation (NSF) in the U.S. provides a compelling glimpse into how supporting social and behavioural science improves the quality of life

Today, the social and behavioural sciences focus on the United States' most critical issues. Through dynamic collaborations with one another and with other scientists, social and behavioural scientists are pursuing many new approaches to our nation's largest challenges and opportunities. Through vast networks of relationships with public and private sector actors, social and behavioural science insights are increasing the effectiveness of the public sector, the efficiency of the private sector, and quality of life for millions of people across our nation.

To see how these effects are happening, consider the context of safety, security, and preparedness. Think about soldiers on a field of battle. Think about first responders in a city whose infrastructure is unexpectedly compromised. Think about a new mother whose automated vehicle is going a bit too fast towards a crowd of unsuspecting people. Each is in a time of crisis.

Critical infrastructure and technology will be built for these moments. Will humans react as planners expect? Will prior instructions be comprehensible? What do we know about the neural and behavioural underpinnings of these split-second reactions?

We know that neuroscience has made great strides in understanding the brain. We know that other scholars have supported important discoveries about human decision making. Yet the gap between what we know about brains and what we know about behaviour is often too wide to apply to split-second decisions. While electroencephalography (EEG) and functional magnetic resonance imaging (fMRI) allow us to infer certain types of neural activity, helping the soldier, the first responder, and the mother requires neural observa-

tions that are more closely linked to behaviour – observations that are beyond our current ability.

## Closing the brain-behaviour gap

Today, the National Science Foundation's Social, Behavioral, and Economic Sciences Directorate (SBE) is helping to close the brain-behaviour gap. On the brain side, we know that the neuromodulators that influence attentional control are different from the neuromodulators that affect other functions. Today, we lack non-invasive means of recording and understanding these differences. Change is coming.

SBE-supported scholars are using an evolving process called resting-state fMRI to link increasingly complex forms of brain activity to performance on split-second tasks. Understanding these linkages gives us great potential to improve performance in many cognitive domains.

This is exciting. Now think about what these discoveries can teach us when combined with new work using single-neuron recording in behavioural contexts.

SBE-supported researchers are recording how single neurons change during memory encoding and memory retrieval. A recent finding from this work clarifies why people can be confident even when their memories are wrong. This work identifies two different neuron populations in the parietal cortex. One neuron population signals whether an item is familiar or unfamiliar.

Another population reflects people's confidence in their judgments. At moments of overconfidence, the two neural networks are sending very different signals about the likely consequences of a decision. The "confidence green light" is overwhelming the "reality





*Dr Arthur Lupia,  
Assistant Director*

red light.” We are on the verge of learning a lot more about when this type of cognitive conflict occurs.

When we combine new abilities to observe neuro-modulators with gains in single neuron recording, brain-behaviour gaps become smaller. When the gaps become smaller, planners, engineers, and programmers can more effectively anticipate split-second reactions. They can use this information to better tailor technology to the needs of soldiers, first responders, parents and other important decision makers. With these changes, transformative advances in safety, security and preparedness are more likely.

### **Tackling many formidable problems**

SBE-funded researchers are tackling so many formidable problems, from the origins of violent extremism to effective ways to mitigate the opioid epidemic; from examining how babies acquire language to clarifying how reading teachers can detect learning impediments. Social and behavioural sciences are also examining how the perception of risk affects decision making in contexts ranging from personal finance to extreme weather. SBE-funded research into human movement has assisted in the development of prosthetics that enable people with disabilities to live independent and full lives. In the same spirit, our agency also supported the basic research on page-rank algorithms that produced search engines like Google.

The world is undergoing rapid change, and SBE-funded research is examining how our citizens and nation can adapt to a fast-changing world. Current research emphases include:

- How women and men returning from military service are transitioning back to civilian life.

- What opportunities and challenges face workers, and others who want to work, when employment landscapes and requirements for new kinds of work are changing at unprecedented speed.

SBE-funded research is examining the effects of these changes on jobs and ways of life for communities, the United States, and the world.

SBE-funded researchers also work with the public sector to improve the delivery and effectiveness of critical public services. For example, although advances in weather forecasting increased the window of time for people to seek safety from life-threatening storms, many people were not listening to government-generated warnings. The National Weather Service and other parts of the National Oceanic and Atmospheric Administration worked with SBE-funded researchers to improve how this critical information is conveyed to the people who need it.

SBE-funded scientists are tackling many of today’s most important questions. Their answers are helping us improve our security, bolster our economy, and advance the progress of science. While there are so many ways to measure the impact of this work, one easy measure is the fact that NSF-supported researchers have won 57 Nobel prizes in economics – more than two-thirds of all such prizes. In fact, NSF has supported every economics Nobelist since 1997.

It is an exciting time for the social, behavioural, and economic sciences, and SBE is grateful for the opportunity to work with so many talented researchers, institutions, and citizens whose work improves quality of life for so many. ■

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# Gender science: Multifractal geometry in predicting the development of a gender stereotype

Damian G. Kelty-Stephen, Assistant Professor at Grinnell College lifts the lid on gender science research, including the work of Anne Fausto-Sterling and the role of multifractal geometry in predicting the development of a gender stereotype

**G**ender science epitomises the complexity of goal-directed experience: it exemplifies nonlinear interaction across many scales of space and time. Nonlinear dynamics provides a particularly good geometry – called “multifractal” – for quantifying, modelling, and predicting such interactions across scales of space and time. That sounds complex which I regret, but I think multifractal geometry is complexity that gender science needs.

## Introducing gender science

For what it’s worth, simplicity in scientific advertising has rarely been good news for gender science. First, developmental science tried to boil gender down into “nature” versus “nurture” probably because the science did not know better. Next, it continued boiling gender down into nature to protect gender diversity against bigoted appeals to unlearn or opt out of non-heterosexual and non-cis identity.

Now, taking oversimplified “born that way” defences of gender to dangerously literal extremes, the Trump administration wants to enact a legal definition tying gender to biological sex. My piece here is about gender, so I will just recommend Sarah Richardson’s book *Sex Itself* for readers inter-

ested in how sex is not a simple function a so-called “sex chromosome.” Generally calling for more nuance in our discourse about gender, I write this piece specifically to recommend multifractal geometry as one of many tools that nonlinear dynamics has to offer an account of gender respectful of gender’s complexity.

The current wisdom in developmental psychobiology is that nature and nurture are completely entangled. They interact at many scales, to such a degree that they are not even separate. Genetic “nature” exerts no effects separate from experiential “nurture.” Epigeneticists in the tradition of Gilbert Gottlieb have shown any simple accounting of “what genes do” separate from “what you learn” absurd, rendering weary statements that “nature and nurture interact” meaningless. Whereas developmental psychology once only envisioned maturational unfoldings of a genetic programme, it now respects the “active child” driving its own trajectory, a bustling organism reaching out to design its own experiences.

And intuitive as it is to imagine an “active child” exploring the playground and leaving a charming path of exploratory destruction in its wake,

developmental psychobiology has struggled to make as clear the epigenetics wrapping everything we thought was “natural” in experientially produced constraints. But epigenetics has been very clear about its complex truths: genes only do what cellular contexts prompt, and behaviour has cascading effects rippling across time and down from the full-body organismic scale, traversing physiological terrain, to the finest systematic changes in gene expression.

## The research of Anne Fausto-Sterling

Gender science is at the forefront of researching this developmental tangle wrought by the active child. Anne Fausto-Sterling explores the rich pattern of touch-based experiences and interactions that children have with their caretakers long before children learn the social codes of gender. With such rich haptic experiences crafting all other aspects of organism development, it becomes less tenable that genetic codes should proceed so smoothly – through the creative chaos of a developing child’s activity – to cleanly transmute into gender outcomes.

Fausto Sterling aligns her work with the expectation that gender emerges

from the necessarily intersectional experience of a developing organism. Intersectionality refers to a pattern of several overlapping constraints at very many scales, from the cultural to the biological, and gender is no simple sum of these constraints – gender is rather the result of the interaction these multi-scale constraints. Gender is neither coded by genes nor a fluke of nurture, and it is instead emergent from the self-same interactions governing the rest of organism-wide development.

## Multifractal geometry – predicting a gender stereotype

To unlock the creative chaos of this active child, Fausto Sterling and Adrienne Harris have both pointed gender science towards nonlinear dynamics. Nonlinear dynamics offers mathematical lenses for modelling interactions across scales. One such intriguing lens is multifractal geometry. Nonlinear interactions across scale generate “multifractal structure.” When development follows from nonlinear interactions across scale, developing systems exhibit very many large slow changes and progressively fewer and smaller fast changes. Using what mathematicians call an “inverse power law,” we can quantify progressive decay in the relationship between size-of-change with speed-of-change. Intriguingly, power-laws are “scale invariant,” meaning that the decay of size-of-change with speed-of-change is the same throughout, suggesting widespread permeability of entire organism to epigenetic-like interac-

tions from grand-scale behaviours to finest gene expressions. Power laws are “fractal” because power-law exponents are often not integers but fractions. Now, nonlinear cross-scale interactions do not just produce one power law but multiple power laws. So, if we study development with an eye to how many and how strong these power-laws we find in time-series of measured fluctuations, then we might get to test the hypothesis that the variety of power-laws (i.e., the multiple fractal patterns: multifractality) could predict the gender outcomes.

Surely, mathematizing gender sounds like a fool’s errand. However, the mathematics that speaks to the convolution and complexity of subtle constructs like gender can speak to interactions across scales even in a brief span of time. You may only need a 2000-word narrative with just enough information to suggest a gender stereotype about an ambiguously-named protagonist and then measure how long people take to read each word. I did just that with collaborators Hannah Brown, Chase Booth, Lizzie Eason, and Sebastian Wallot. We asked whether multifractality geometry in word-reading times could predict the development of a gender stereotype. When readers reached the 1000th word with a plot twist thwarting the cued gender stereotype and showing the ambiguously named protagonist having an unexpected gender, readers slowed down to gather their startled thoughts before pressing forward again. Multifractal geometry of word-readings

series up to that point predicted individual readers’ differences in how much and how long readers slowed down. After almost as brief a text as appears here, multifractal geometry allowed us to predict the development of a gender stereotype. Interestingly, the startled readers went on to read the remaining text with markedly increased multifractal structure.

Certainly, learning new math sounds dreary and intimidating, and maths seems too harsh and unfeeling a thing to reveal the heart of our experience of gender. But simplicity is cheap. Nonlinear-dynamical complexity respecting the known intersectionality of gender may reap quicker insights.



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# The social context of innovation

Professor John F. Padgett uses social network analysis to illuminate how borrowing tactics from seemingly unrelated social phenomena converged to facilitate revolutionary change across Florence

**T**he Renaissance in Florence, Italy was one of the most innovative times and places in Western Europe, generating world-altering advances in art, political thought, science, banking, public finance and republicanism. Scholars have long sought to understand the social context in this city that produced not only particular innovations, with their own local histories, but also spill overs in innovation from one domain to another.

Using primary archival sources, Professor John F. Padgett of the University

of Chicago has devoted 30 years to assembling a database that traces the historical evolution of multiple social networks in the city, among about 80,000 persons over 150 years (1350–1500). These range from kinship and marriage networks, to economic partnerships and commercial credit, to political elections, factions, and public debates. This research has been funded by the US National Science Foundation, the Hewlett Foundation, and the Neubauer Collegium.

Inspired by the biological sciences, where relationships between

molecules within an organism, and organisms within an ecosystem, are often context dependent and best understood through network representations, Professor Padgett's work seeks to understand how complex social networks facilitated innovation in Renaissance Florence. As with a biochemical reaction, innovations in one social network were often catalysed by activity in adjacent social networks.

In a series of studies into each of the evolving social networks listed above, Professor Padgett and his team have identified an organisational innovation



or change of focal interest, and have situated that innovation in the multiple-network context of its production. For example, if focal attention is on banking innovation, Professor Padgett and his collaborators reconstruct in person-by-person detail not only the economic networks of those bankers but also their kinship and political networks. Florentines, after all, were the historical source for our current stereotype of 'Renaissance Men' (and perhaps not as many women as we would like, but some).

Though revolutionary innovations often appear to have sprung from thin air, the team's work demonstrates that they are often the product of a combination of forces that may seem unrelated on the surface. These networks illuminate factors adjacent to an innovation that shaped its emergence and ultimate form.

## **Social network structure enables revolutionary political change**

In a study of the rise to power of Cosimo de' Medici, the founder of the Medici political dynasty during the Florence Renaissance, Professor Padgett traced the unusual degree of centralisation of this revolutionary faction in the marriage- and business-network social foundations of its emergence. This unique example represents Florence's transition from the late medieval tradition of numerous urban political factions to the birth of a united Renaissance state.

Prior to Medici, Florentine politics consisted largely of competition between guilds and wars between urban feudal houses. Professor Padgett and his colleagues focused on Medici's 'social embeddedness' – the ways in which his social relationships shaped and

enabled his rise to power to form the Florence state.

Cosimo de' Medici had many vocations and connections and was a member of both elite marriage networks and numerous business partnerships, which allowed him to behave opportunistically in each of his circles to shape interactions between them. Since he was the singular point of overlap between some of these circles, he was at low risk of being found out when supplying contradictory information to different groups.

This allowed him to take robust action when opportunities to advance his own interests or hinder his opponents' power presented themselves, ultimately moving the Medici family into a position of power over a much broader region than ever before. Through his social connectedness,





Cosimo de' Medici was able to leverage the existing system of inter-guild and inter-family feuding to create an entirely new system.

## Economics shaped by family and friendship

In the 1380s, a new form of business organisation emerged in Florence – the partnership system. For the first time, rather than companies being exclusively run by a single person or family, businesses emerged with multiple legal owners or partners from different families.

These partnerships formed the basis for financial capitalism by protecting business owners from financial ruin in the case of a business failure. It also allowed companies to simultaneously become more generalist and more specialised: the overarching company could cover many markets, while the

various partners could specialise in their market within the company.

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**“Though revolutionary innovations often appear to have sprung from thin air, the team’s work demonstrates that they are often the product of a combination of forces that may seem unrelated on the surface. These networks illuminate factors adjacent to an innovation that shaped its emergence and ultimate form.”**

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Through a network analysis inspired by biochemical pathways, Professor Padgett found that the business innovations, in this case, were not strategized, rather an unintended consequence of repression of class revolt. Prior to the partnership system, businesses were based primarily on paternal inheritance or membership in a guild. As these systems became destabilised in a changing urban political environ-

ment, marital ties and client pressure began to determine the direction of businesses. This reorganisation of elite social networks to favour victorious pairings encouraged the partnership system to emerge.

Another critical innovation in capitalism was the development of economic credit markets. Businesses relying on commercial credit was unheard of prior to the Renaissance, but in Florence, a system emerged by which trading partners began offering and tracking credits and debts of goods.

By analysing records of credits and debts between Florentine businesses along with marital and political ties, Professor Padgett and his team were able to construct a more complex understanding of how the credit system emerged. As with many of Florence’s innovations, social ties played a



major role. The public reputation and social status of a business owner influenced their ability to secure a loan. Friendship and kinship were the initial determiners of who got credit or not, but increasing tax scrutiny from an evolving political landscape eventually forced the formalisation of a mathematically advanced credit system.

These Florentine multiple-network-rewiring processes have been generalised to the other historical cases of the emergence of organisational novelty: the stock market in early-modern Amsterdam, the consolidation of Germany in the 19th century, the divergent outcomes of similar economic reforms in the Soviet Union and China, and the emergence of the biotechnology industry in late 20th-century America. Underlying this generalisation of Florentine insights to new applications is Professor Padgett's adaptation of the concept and models of 'autocatalysis' from the biological literature on the origins of life.

## Blurring class lines through new status symbols

Kinship and marriage have long played a major role in determining social status in class-based societies. Medieval class structures based on feudal systems were rigid and categorical, with limited class mobility and marriage prospects relegated to within one's designated group; elite families only married to other elite families. During the Renaissance, Florence saw the breakdown of this medieval social status and hierarchy among categorical groups into a continuous hierarchical status with potential for mobility.

Once again, Professor Padgett and his colleagues were able to use records to determine the social networks that made this transition possible. They found that during this time, social

stratification could be determined by either wealth, political office, or age of family. However, rankings of a family within each of these three systems often did not align. Thus, a member of a family with great wealth but poor political standing could marry a member of a less wealthy family with an old name.

**"Another critical innovation in capitalism was the development of economic credit markets. Businesses relying on commercial credit was unheard of prior to the Renaissance, but in Florence, a system emerged by which trading partners began offering and tracking credits and debts of goods."**

As families sought to make suitable matches across these three components, it opened the door for new men who were successful in politics or business to marry into old families, gaining upward social mobility. As a result, distinctions between elite families began to blur and become more fluid. Just as marital ties shaped Florentine economics and politics, developments in economics and politics made novel marriage pairings possible.

## Expanding social understanding

Currently, Professor Padgett is in the process of extending his multiple-network and autocatalysis ideas about social innovation to language. He is studying William Faulkner and political debate in the Florentine Consulte e Pratiche to uncover how social networks shaped the linguistic landscape of the Renaissance.

## Nothing occurs in a vacuum

In all of these cases and others, social-organisational innovation came from cross-network advances and the recombination of multiple networks. Every Renaissance innovation can be

tied to activity in adjacent social networks. For example, radical economic change does not occur through the evolution of one network in isolation, but rather the evolution of that network in the surrounding 'catalytic' context of kinship and political networks. Advances in any one network fuelled new processes in others, creating an innovation feedback loop that ultimately shaped the course of European history.

One of Professor Padgett's most intriguing findings is that innovative Florentines were usually conservative in their motivation; seldom were they setting out to create something novel, instead simply working to improve upon the familiar. Innovation occurred not so much by the intentional invention of new tools for old purposes, as by the opportunistic adaptation of old tools for new purposes.



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# Building a university climate of inclusive excellence for women and minorities in the fields of STEM

Dr Suzanna M. Rose from the Office to Advance Women, Equity & Diversity, Academic Affairs shares her views on working towards a university climate of inclusive excellence when it comes to the representation of women and minorities in the fields of science, technology, engineering, and mathematics (STEM)

The representation of women and minorities in the fields of science, technology, engineering, and mathematics (STEM) has not kept up with the dramatic growth in the STEM fields over the past few decades. This is true both in the workforce and in academia.

The Office to Advance Women, Equity & Diversity (AWED) at Florida International University (FIU) was established to address this issue by achieving and sustaining faculty equity and diversity in STEM, as well as other fields. With the award of a National Science Foundation Institutional Transformation grant, AWED set out to combat the issue by launching FIU ADVANCE, a five-year, \$3.2 million dollar programme to develop innovative organisational strategies that would produce comprehensive change across STEM and other disciplines.

FIU is both a Hispanic-Serving Institution (HSI) and a Minority-Serving Institution (MSI) that is designated as a Very High Research University within the Carnegie classification. FIU is among the ten largest universities in the U.S. with 57,000 students. Its students are 61% Hispanic and 20% from other underrepresented groups

(URGs). FIU is one of the top schools in the country in the number of bachelor's and master's degrees awarded to Hispanic students, as well as in awarding STEM degrees. However, like many academic institutions across the country, the same levels of diversity are not seen at the faculty level. In 2016, the percentage of women in tenure-line, research faculty positions in STEM was just 18%, and only four of the 255 combined STEM faculty members were women of colour.

The goals of FIU ADVANCE were influenced partly by previous research completed by Rose and colleagues showing that foreign-born STEM men faculty demonstrated strong preferences for hiring from within their own cultural group (Rose & Farhangi, 2016). This led the team to explore the intersectional identities of foreign-born men STEM faculty to see if their cultural beliefs also might pose an unaddressed barrier to attracting and hiring Hispanic-American and African-American women in STEM. For instance, findings based on interviews and focus groups indicated that some international faculty members tended to have beliefs about women and gender from their home cultures that were at odds with the more egalitarian ideas

common in the U. S. Others considered racial issues as being a "U.S. thing" and believed themselves to be immune from it, even while expressing U.S.-based racial stereotypes and prejudices.

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**"A diverse faculty has positive effects on our diverse student body. More perspectives are taken into account and increased diversity gives us access to talent currently not represented among faculty and students."**

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The team, thus, determined that, in order to create a truly diverse community, an atmosphere of inclusion and openness must be fashioned and underlying biases of both U.S. and international faculty must be addressed in order to succeed at hiring more women and members of underrepresented groups.

## **Building an inclusive culture at FIU**

In response, several programmes have been created that focus on building an inclusive culture at FIU. Even before search committees begin their work to recruit candidates for a particular faculty position, committee members are required to attend a STRIDE Workshop (Strategies and Tactics for Recruiting to Improve Diversity and



*Prof. Svetlana Roudenko, Mathematician and Diversity Mentor Professor, and Suzanna Rose, Associate Provost, AWED*

Excellence). The faculty-led workshops provide participants with background information and concrete advice about practices that make searches more effective at producing diverse candidate pools and more successful at hiring the candidates that departments want to attract.

Faculty also may participate in the Bystander Leadership Program, a workshop that is intended to raise awareness of implicit bias and provides experience with using a variety of diplomatic responses to both subtle and obvious situations involving gender or race bias. A crucial component of the programme is AWED theater, that presents skits tailored to the academic setting using professional actors to encourage attendees to interact with each other and the curriculum. Attendees discuss a toolkit of response options available to them and then take part in simulations in which they practice the techniques. Participants attest that the practice sessions are especially important for increasing their confidence in using intervention skills and strategies.

## **FIU's Diversity Mentor Professorships programme**

Another initiative aimed at increasing diversity is FIU's new Diversity Mentor Professorships, a programme launched in 2017-2018 to recruit excellent research scientists and engineers with a history and commitment to the mentorship of women students and students from traditionally underrepresented groups. Research has shown that having a female role model has a powerful positive effect on women's performance in maths and science classes.

Suzanna Rose, associate provost, AWED, says that: "A diverse faculty has positive effects on our diverse student body. More perspectives are taken into account and increased diversity gives us access to talent currently not represented among faculty and students."

## **Helping create female role models and leaders**

A further programme run by AWED and designed to help create female role models and leaders on campus is

the Women Faculty Leadership Institute (WFLI). This annual symposium is designed to promote women's leadership and strategic career planning. WFLI focuses on enhancing skills and thinking broadly about women's issues.

As of fall 2018, the STRIDE workshops were institutionalised (with a three-year phase-in) to be required of faculty search committee members in all colleges and departments, and more than a hundred faculty members have taken part in a Bystander Leadership workshop. Additionally, the development of university-wide faculty diversity and inclusion plans was launched during the same semester.

The number of women in STEM is now at 20%. FIU ADVANCE, therefore, can already claim positive results in its goal to create a faculty-based social system that proactively enhances a culture of inclusion for all faculty at FIU.

Rose, S. M. & Farhangi, S. (2016). The intersectionalities of men STEM faculty: An unexplored barrier for recruiting women of color? Association for Women in Science, 48, 16-19.



**FIU** | **Advance Women, Equity & Diversity**

### **Dr. Suzanna M. Rose**

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# Commercialising space: Is the UK space industry ready?

Having recently launched the first all-British radar satellite and with Britain's first spaceport due to become operational in Scotland by 2020, it is clear that the UK's space sector is thriving. But is it ready to capitalise on this position of strength when it comes to commercialising space?

Paul Adams, Head of Aerospace at Vendigital tells us more

**"**It is no secret that the UK space sector is growing rapidly at the moment. The UK government has set out bold ambitions to secure 10% of the global space market by 2030 – with an approximate value of £40 billion<sup>(1)</sup>, triple the size it is today."

Legislation passed earlier in 2018 also means Britain now has the regulatory framework in place to control commercial spaceflight and grants from the UK Space Agency have been set aside to help develop a commercial launch capability for spaceflight by 2020. To facilitate this, there are plans in place to develop four new spaceports – one in Sutherland on the north coast of Scotland, as a launch site for small satellites, and three further 'horizontal' launch sites, capable of supporting manned rocket launcher programmes and satellite launches, at Cornwall, Glasgow Prestwick and Snowdonia.

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**"The UK space industry is also well-known for its commitment to high-quality manufacturing, which despite being instrumental in establishing its current market position, must now be balanced against a need to increase scale and ensure speed to market."**

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The rapid expansion of the global space market is being driven by many factors. In particular, demand for small satellite launchers and the data they provide to governments and public agencies around the world has soared in recent decades. The data collected and sent back to Earth from existing small satellite constellation programmes is being used in a variety of ways – from monitoring endangered whale populations to identifying floating plastic waste and improving our understanding of air pollution.



*Paul Adams, Head of Aerospace*

The UK Space Agency has estimated that about 40% of the small satellite systems currently in orbit were built in Britain and our manufacturing capability in this area is particularly strong. In addition, the cost has become a strategic driver for the industry, enabling the delivery of satellite constellation programmes that were not previously economically viable. This, in turn, is opening the door to more entrepreneurial, private operators, in the UK and globally.

If further impetus were needed to drive UK space investment at the current time, Brexit has provided some. The EU has confirmed that Britain will no longer

have access to its Galileo Navigation Satellite System after Brexit and whilst the UK government intends to continue to collaborate in Europe after Brexit, it has responded by announcing a £95 million investment to build its own Global Navigation Satellite System (GNSS). This investment is a boost for the domestic space sector at a time of economic uncertainty but, in reality, it is still some way short of the amount required to launch such a system. Collaboration may provide the solution, and the recent agreement to cooperate with the Australian Space Agency could be significant.

Despite considerable momentum and investment in the sector, some significant challenges lie ahead, on route to what has been dubbed the 'Great British Space Age'. One growth-limiting factor is a global lack of manufacturing capacity, which is making it hard for the industry to keep pace with the demand for small satellite parts and services. This could be preventing costs from falling further.

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**“It is no secret that the UK space sector is growing rapidly at the moment. The UK government has set out bold ambitions to secure 10% of the global space market by 2030 – with an approximate value of £40 billion, triple the size it is today.”**

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The UK space industry is also well-known for its commitment to high-quality manufacturing, which despite being instrumental in establishing its current market position, must now be balanced against a need to increase scale and ensure speed to market. There are numerous examples of opportunities to bring commercial off-the-shelf technology to bear at both a system and component level, without impacting quality. This can help to reduce direct cost and remove capacity constraints.

Indeed, from a cost perspective, the industry has many opportunities to strengthen its position further. Amongst them, a greater understanding of supplier markets could be used to drive competition. For example, OEMs able to compare the quality standards that apply in different parts of the world will be able to buy from a much broader, global selection of suppliers and take advantage of the cost and innovation benefits that competitive markets bring.

To strengthen its market share in the future, the UK's space industry must also expand its manufacturing capability and gain access to global rocket engine technology. This will require a greater focus on cross-industry collaboration and knowledge-sharing initiatives. It will also be necessary to establish an ecosystem of high-quality suppliers to fulfil maintenance and fuelling contracts, as well as providing a domestic source of specialist materials and components. A great example of this is Orbex, which has developed an innovative launcher, using British-made parts and equipment, that uses bio-propane propellant, as oppose to hydro-carbon fuel, in order to reduce carbon emissions.

These are exciting times for the UK space industry – both for new entrants and those that have already secured a strong reputation in the international marketplace. With the right funding in place and a favourable headwind from Brexit, the government's ambitions for the market's expansion could be met. ■

(1) The UK government's 'Space Innovation and Growth Strategy' states that the global space market will be worth £400 billion by 2030, based on current estimates.

**Paul Adams**  
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# Advancing the knowledge of space through science

The work of The Canadian Space Agency (CSA) in advancing the knowledge of space, through science and using its discoveries to benefit Canadians and all of humanity, is detailed here

The Canadian Space Agency (CSA) is responsible for advancing the knowledge of space through science and using its discoveries to benefit Canadians and all of humanity. Set up in March 1989, the CSA is an independent federal agency that takes charge of managing all of Canada's civil space-related activities.

The CSA focuses on three main areas, which this article will examine, as well as the importance of this key sector for the Canadian economy:

**1. Space exploration:** Taking part in astronomy and planetary studies, astronaut missions, as well as scientific research in space (execution and support).

**2. Space utilisation:** Earth observation by the collection of spatial data and satellites.

**3. Space science and technology:** The development of innovative space technologies and applications used on Earth. <sup>(1)</sup>

## Space exploration: Canadian Space Agency astronaut David Saint-Jacques

On space exploration, we know that astronauts today are modern-day explorers, indeed, they courageously travel to seek new scientific knowledge. At the time of writing, only a few hundred exceptional people have been beyond Earth, into space. In December 2018, Canadian Space Agency astronaut David Saint-Jacques flies to the International Space Station on his first mission. During his assignment, he conducts a number of scientific experiments, as well as robotics tasks and the testing of new technologies. <sup>(2)</sup>

David Saint-Jacques was born on 6th January 1970 in Quebec City, Canada. Today, he is married and has

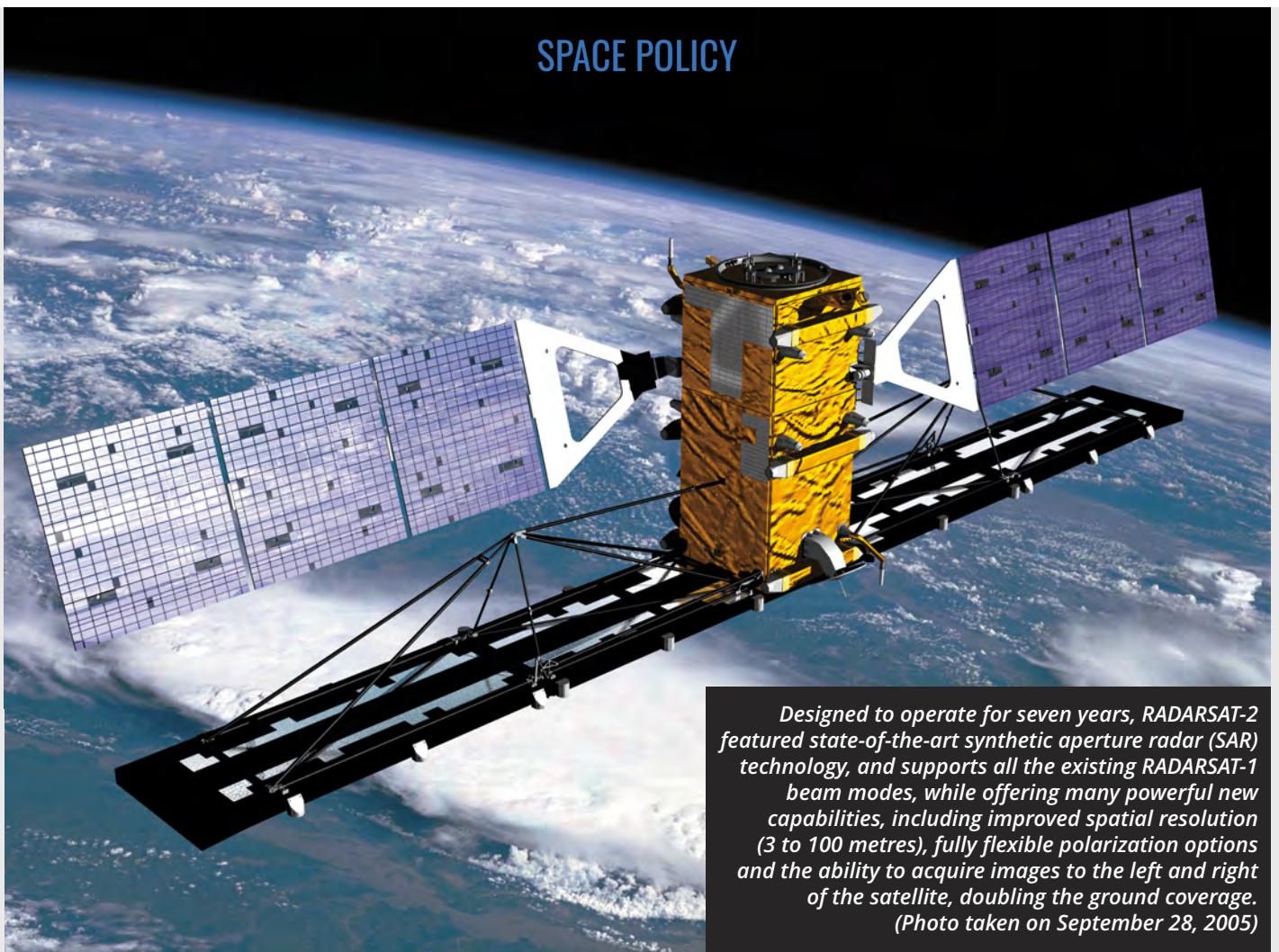
three children. He also holds a commercial pilot licence with multi-engine and instrument ratings, as well as an advanced scuba-diving licence. He is also a lifelong cyclist, mountaineer, skier and avid sailor. In addition, he is fluent in English and French and can also converse in Russian, Japanese and Spanish. In a question and answer session with David Saint-Jacques, we find out what motivated him to become an astronaut, which he details in his own words.

"As a child, I was impressed by photos of Earth taken from the moon. They showed me the immensity of the universe around us, the splendour and obvious fragility of our planet. Growing up, I was drawn to a life of adventure, exploration and discovery. I didn't think that becoming an astronaut was a real possibility, but my fascination with space remained, and that childhood dream has motivated me to reach my full potential as a human being.

"I wanted to learn everything, both about the sciences and world cultures. To be an explorer, I also had to become a responsible and trustworthy adult. Opportunities for discovery have presented themselves in many forms: science, medicine, living abroad. When I learned one day that astronauts were being recruited, the dream returned, and the little boy I once was convinced me to apply."

An interesting point raised in this interview with David Saint-Jacques is that each profession he has worked in has prepared him well to go into space. For example, his experience as an astrophysicist taught him the discipline of research and the joy of scientific discovery as he worked in observatories globally, as a part of international teams who were determined to push forward the boundaries of knowledge. "As an engineer, I especially enjoy the creativity and the satisfaction of





*Designed to operate for seven years, RADARSAT-2 featured state-of-the-art synthetic aperture radar (SAR) technology, and supports all the existing RADARSAT-1 beam modes, while offering many powerful new capabilities, including improved spatial resolution (3 to 100 metres), fully flexible polarization options and the ability to acquire images to the left and right of the satellite, doubling the ground coverage. (Photo taken on September 28, 2005)*

finding a solution to a practical problem that is so elegant, so reliable and so ergonomic that in the end, you take it for granted. When an engineer has done their job well, it works, and that's all there is to it!", David Saint-Jacques explains. <sup>(3)</sup>

## Space utilisation: Earth observation

The second aspect of the CSA's work concerns observing the Earth from space and as such, satellites give vital information on the ocean, ice, the atmosphere and land environments. Earth-observation satellites assist with the monitoring and protection of the environment, ensuring the safety and security of Canadians and managing resources. Certainly, satellite imagery and expertise are also used to support sustainable development and global humanitarian efforts.

An example of this part of the CSA's work is The International Charter "Space and Major Disasters", which is an international effort to put space technology at the service of rescue and emergency responders in the event of a major disaster. Certainly, we know that when the Charter is activated, its members make satellite images of devastated regions available to support relief efforts.

RADARSAT-2 imagery regularly provides support to rescue teams on the ground. Armed quickly with reliable and accurate information, response teams are better equipped to save lives and limit damage to property, infrastructure and the environment. One good example of this kind of work given on the CSA's website is October 2018's Hurricane Michael, a Category 4 storm, one of the strongest to hit the United States. <sup>(4)</sup>

## Space science and technology

When it comes to supporting Canada's space sector in the advancement of innovative space technologies and applications, we know that the power of science is as infinite as space. The Government of Canada believes it is vital to engage Canada's youth in science and provide them with the tools to make science a part of their lives.

On 24th October, the Honourable Navdeep Bains, Minister of Innovation, Science and Economic Development, Canadian Space Agency (CSA) astronaut David Saint-Jacque and Bonnie Schmidt, Founder and President of Let's Talk Science, launched a new youth science research project that will give students in



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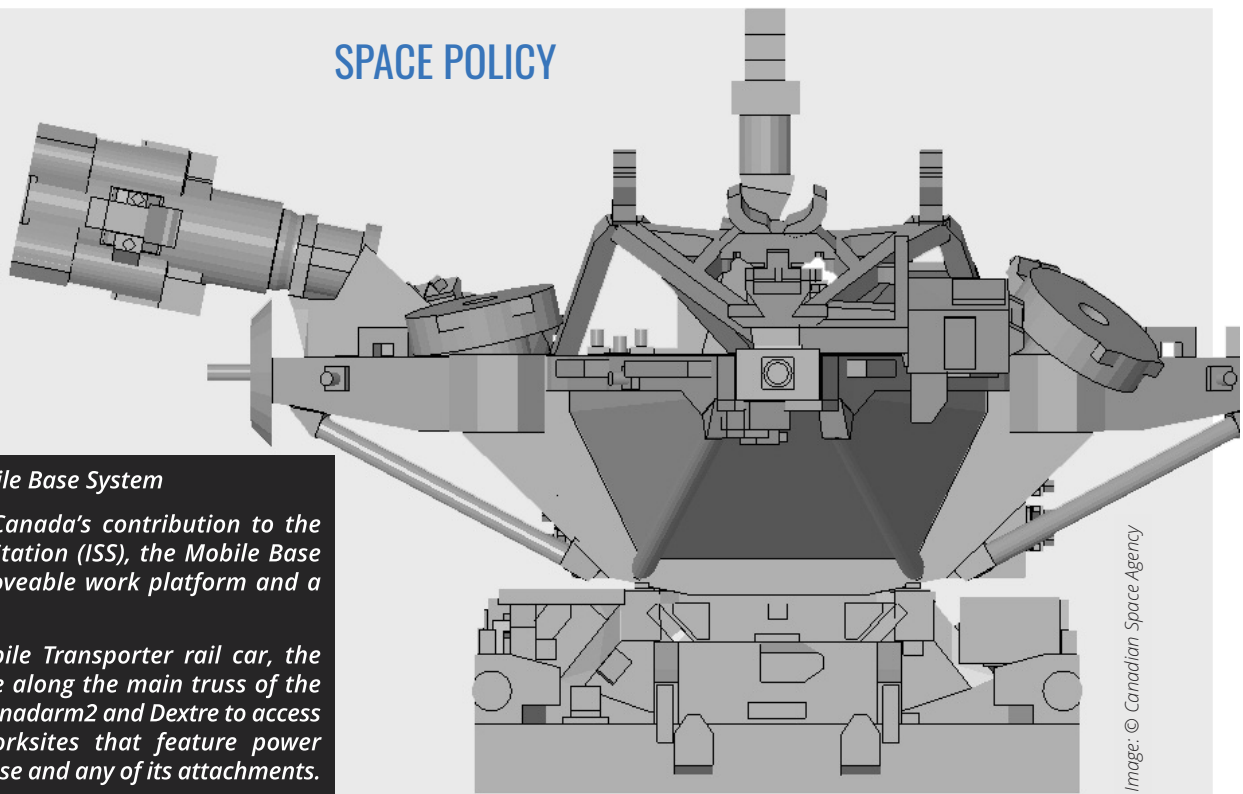


Image: © Canadian Space Agency

### 3D printing – the Mobile Base System

21-09-2018. Part of Canada's contribution to the International Space Station (ISS), the Mobile Base System (MBS) is a moveable work platform and a storage location.

Mounted on the Mobile Transporter rail car, the Mobile Base can glide along the main truss of the ISS. The MBS allows Canadarm2 and Dextre to access any of the eight worksites that feature power connections for the Base and any of its attachments.

← Continued from page 175

Canada a unique opportunity to collect and compare environmental data from Earth and space.

The Honourable Navdeep Bains, Minister of Innovation, Science and Economic Development said at the time that when he was at school, he could only dream of contributing to experiments in space. "Now, our government is making this a reality for future Canadian scientists, engineers and leaders in innovation through the Living Space project. By investigating scientific concepts and learning digital skills, like coding and analysing data, our children will have limitless opportunities to succeed in the jobs of tomorrow", the Minister said.

David Saint-Jacques, Canadian Space Agency astronaut stated that he wants to engage young Canadians on his mission, a point he elaborated on in his own words. "I was inspired by the Apollo moon missions, and that gave way to an insatiable curiosity about technology, our planet and the universe that fueled my education and career path. I hope that through this mission and activities like Living Space, the Canadian Space Agency and I can inspire young Canadians in the same way. I can't wait to see the results of their research projects." <sup>(5)</sup>

### Supporting a key sector of the Canadian economy

In closing, The Honourable Navdeep Bains, Minister of Innovation, Science and Economic Development leaves

us with positive thoughts following his announcement on 15th October 2018 that the CSA is investing \$1.6 million in two concepts for lunar rovers that would use artificial intelligence (AI). His comments encompass the aspects of Canada's space sector explored in this article, including inspiration for space exploration and the development of science, technology and innovation in the field.

"Canada's space sector not only inspires Canadians to reach for the stars, it has for a long time been at the forefront of Canadian science, technology and innovation. With these investments, our government is supporting a key sector of our economy that creates good jobs and will continue to propel Canada's innovation economy to new heights." <sup>(6)</sup> ■

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# Dark matter: Advanced exploration at SNOLAB

Dr Gilles Gerbier, Dr Art McDonald and Dr Antony Noble delve into the unknown world of dark matter, the unidentified mass that physicists are still yet to solve

**D**id you know that more than 80% of the Universe's mass is unknown? The fraction that we do know about is composed of planets, stars, and well, us, but the majority of the Universe is composed of unknown mass. What exactly this unknown mass is, as it has never been directly detected, is one of the great questions left facing physicists today.

Even though this unknown mass has never been detected, it does have a name: dark matter. But wait, if it has never been detected, how do we know it exists? Based on observations, astrophysicists discovered that galaxies were spinning much faster than expected based on calculations from existing known "bright" matter, that is, there shouldn't be enough gravitational force in the glowing stars to hold the galaxies together. Yet galaxies so rarely disintegrate, there is clearly some other source of gravity that is holding everything together. This mysterious substance was dubbed dark matter.

But what is it? There have been many particle candidates over the years: axions, gravitinos, among others, but the current theoretical particle still showing the most promise is the WIMP, or Weakly Interacting Massive Particle. The "weakly interacting" part is what makes a WIMP so hard to detect. Here is the picture: the solar system and its planets, like the Earth, is bathing in a halo of WIMPs flying

around and once in a while interacting with nuclei of ordinary matter.

Efforts have been made, of course, to detect it in underground labs around the world, and to 'make' it in the Large Hadron Collider, similar to its creation in the Big Bang. All of these attempts have been unsuccessful so far, and dark matter has remained as elusive as ever.

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**"Did you know that more than 80% of the Universe's mass is unknown? The fraction that we do know about is composed of planets, stars, and well, us, but the majority of the Universe is composed of unknown mass."**

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What if it is even more elusive than anticipated and/or if its properties escaped the attention of traditional searches? New ideas to enlarge the parameter space of exploration and especially include lower mass Dark Matter particles are then called for to extend the sensitivities tremendously.

The three projects described below, in which the three authors are involved, use complementary cutting-edge technologies to address these new challenges. To detect such minuscule signals, the experiments will be installed underground in SNOLAB and LNGS, Italy, to protect them from sources of "backgrounds" simulating signals. SNOLAB, near Sudbury, Ontario is one of the deepest and the

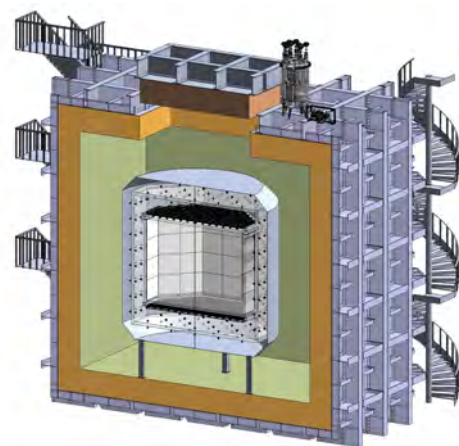
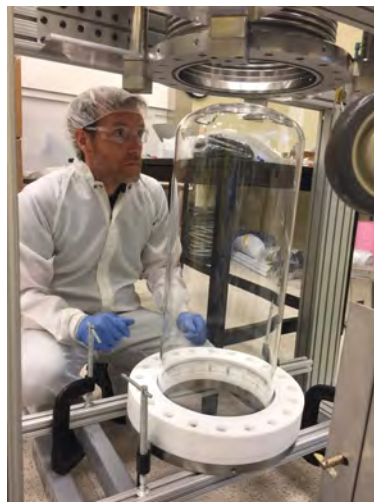
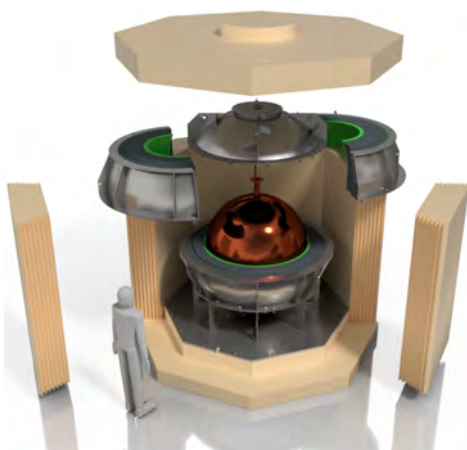
cleanest underground laboratory in the world. All existing projects are international and nationally supported by NSERC and CFI. The McDonald Institute provides additional human and technical resources coordinated between 11 institutions in Canada.

The Arthur B. McDonald Canadian Astroparticle Physics Institute (McDonald Institute) is a CFREF-funded scientific network supporting Canada's Astroparticle Physics research community. Its chief concern is growing and connecting the community to solve major scientific questions like the detection of dark matter. It administers funds to expand the talent pool of faculty, graduate students and fellows working in dark matter, neutrinos and related research. The Institute works with major experimental and theoretical facilities in Canada and is maximizing economic and social benefit of large-scale research to better engage the public with the work of astroparticle physicists. See [www.mcdonaldinstitute.ca](http://www.mcdonaldinstitute.ca) for more details.

## Three projects to go beyond the present status

### NEWS-G: a new window on light dark matter

NEWS-G uses a new type of spherical gaseous detector developed within a Europe-North America collaboration, to be sensitive at the unexplored



The 3 projects : NEWS-G, PICO and DarkSide-20k

lower end of the particle mass range, comparable in mass to a proton or below. Here the ability of such detectors to detect extremely low current pulses, equivalent to a single electron, combined with the use of “light” targets, like helium, or hydrogen are keys for this exploration. The new 140 cm diameter detector with its shields will start operation in 2019 at SNOLAB.

### **PICO: a unique ultra-sensitive detector listening for dark matter with spin!**

PICO has a very unique approach to search for dark matter. The core of the detector is a superheated fluid (C3F8). The fluid is still a liquid, despite being well above the boiling point. A small energy deposition from a WIMP interaction can initiate boiling and the creation of a gas bubble. These are easily identified using high-speed cameras, and the popping sound is heard with sensitive microphones. WIMPs can be distinguished from fake radioactivity signals through their characteristic optical and acoustic signals. PICO is world-leading in the search for dark matter particles with

spin and the collaboration are currently upgrading their detectors to increase the sensitivity by a factor of 100.

### **GADMC: a worldwide multi-ton scale project to reach an ultimate sensitivity using liquid argon.**

Liquid argon gives out a very short burst of light from a dark matter particle, but a much longer burst from background radioactivity, so it is easy to tell them apart. Right now, there are 3 tonnes of argon operating in the DEAP detector at SNOLAB and an international collaboration of 350 scientists from 12 countries have come together to build a 20-tonne detector to be built in Italy (DarkSide-20k), followed by a 300-tonne detector, likely to be installed in SNOLAB. Increasing the sensitivity a factor of 100 may be close to the ultimate sensitivity, as the main background is neutrinos that cannot be shielded by an underground location.

### **Synthesis**

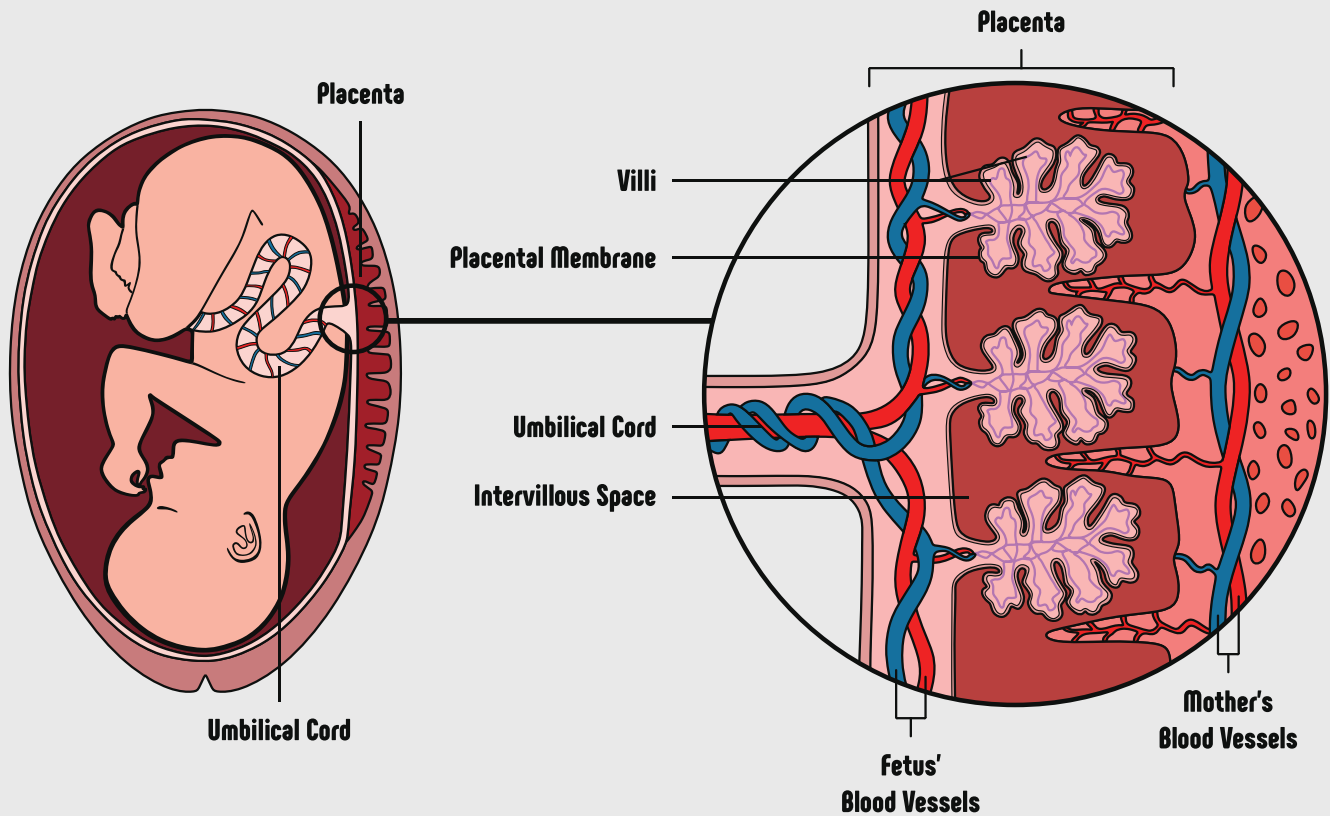
At Queen's University, under McDonald Institute banner, G. Gerbier, holder of a CERC in astroparticle physics and PI

of NEWS-G, T. Noble, PI of the PICO program, former director of SNOLAB, scientific director of MI and A. McDonald, former director of SNO project, Nobel Prize winner and active promoter of GADMC, join together their skills, enthusiasm and teams towards identifying the nature of dark matter, one of the most arduous modern physics questions, holding physicists attention for close to a century now.

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# The Human Placenta: A short-lived organ, with a long-lasting impact

Dr David Weinberg from the Human Placenta Project, a program of the Eunice Kennedy Shriver National Institute of Child Health and Human Development (NICHD), part of the U.S. National Institutes of Health, details why the human placenta is a short-lived organ, yet has a long-lasting impact

**T**he placenta is the least understood human organ and arguably one of the most important, not only for the health of a woman and her foetus during pregnancy but also for the lifelong health of mother and child. Though we've all been connected to a placenta, many of us rarely think about the role of this sophisticated, multi-tasking organ in launching our lives.

The placenta serves as the lungs, kidneys, and liver for a developing foetus. It brings oxygen and nutrients and

discards waste. Yet, the organ is immediately discarded after birth, under-appreciated and under-studied.

We hope to change that.

Our ambitious Human Placenta Project (HPP) aims to monitor the placenta in real time as it changes shape and form during the course of pregnancy. Our goal is to harness advanced technology and developing tools that can detect when the placenta fails to function properly. If we can learn early on that typical develop-





*Placenta oximeter*



*Dr David Weinberg  
Project Lead*

The placenta releases small particles, called vesicles, into the maternal blood that may yield clues to the health and function of the placenta. Since the Human Placenta Project started five years ago, researchers already have developed new methods for isolating and analysing these vesicles. Scientists are studying their content looking for clues that would possibly identify biomarkers to show when pregnancies face problems.

One of the newest research developments at NICHD is a small, hand-held device, the size of a mobile phone, that can be strapped around a pregnant woman's belly to monitor oxygen levels to the foetus – a key to detecting early pregnancy complications. While still at the early stage of development, such a device might be a cost-effective tool for use in low-resource settings.

## Hope for the future

At the very first HPP workshop, I remember a physician telling me that in the past there had always been only two choices for doctors facing a pregnancy complication: deliver the baby early or wait and hope for the best. Such limited choices should be unacceptable. The goal of the HPP is to make them archaic. ■

For more information about the Human Placenta Project, visit:  
<https://www.nichd.nih.gov/research/supported/HPP/default>

To read about the most recent research projects funded in 2018: visit:  
<http://bit.ly/2qTFxAN>

## Dr David Weinberg Project Lead

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ment has gone awry, we can identify possible pregnancy complications, such as preterm birth, preeclampsia, or fetal growth restrictions – and make it possible to intervene.

New advanced monitoring tools allow us to glean information about the placenta as it develops, without compromising the health of mother and foetus.

## Global expertise to make a difference

Recognising the need to tap scientists from diverse fields, HPP has invested more than \$60 million to support the development of novel technologies, from MRI and ultrasound to measurement tools that read signals in the mother's blood. Achieving our goals will require a concerted commitment from across the globe. HPP was launched with input from the Trophoblast Centre for Research in Cambridge, as well as researchers at Oxford University and King's College of London.

## Progress and novel approaches

Imaging the placenta presents unique challenges. Even the slightest movement by the foetus or simply the mother's breathing can temporarily distort the shape of the placenta shape and make it difficult to get clear images. Advances in imaging technology have allowed researchers to capture clear images of the placenta doing its job transporting blood and oxygen between mother and foetus.

# Love as medicine

Dr Sue Carter, Director of the Kinsey Institute provides an expert insight into the role of oxytocin, a hormone that helps to explain the healing power of love

Love is intrinsically beautiful, but also complex and mysterious. Although love can be difficult to define, the list of love's functions is long. Love influences all aspects of human existence. Love is powerful medicine. Healthy relationships can protect against disease and restore the body in the face of illness.

Without loving relationships, humans fail to flourish, even if all of their basic needs are met. "Love lost" is one of the most powerful forms of stress and trauma. We now understand that the causes and consequences of love or its absence are grounded in a biology that operates largely below the level of human consciousness.

---

**"The mechanisms through which love protects and heals are only now being discovered."**

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Remarkably, the origins of this knowledge began in research conducted in a small field mouse known as the prairie vole. In the 1980s, working at the University of Illinois, my colleague Lowell Getz and I uncovered evidence that both in nature and in the laboratory, prairie voles were capable of forming life-long pair bonds. In this species, both parents nurtured the young, with fathers sharing all aspects of infant care except nursing. Older siblings also cared for younger babies. Juvenile prairie voles left the family to find mates and scrupulously avoided incest. Prairie voles exhibited the

traits of the mating system that humans associated with monogamy.

As in humans, the core of the prairie vole monogamy was based on social bonds, not simply defined by sexual exclusivity. The capacity for pair bond formation was regulated physiological and emotional states, based on neural systems also found in humans. We also found that prairie voles have high levels of oxytocin, a human-like autonomic nervous system, and they are exquisitely sensitive to the neural and epigenetic effects of early nurture. Thus, by studying pair bonding in voles, we had created a laboratory model allowing us to examine the neurobiology of what humans call "love."

The evolutionary and biochemical prototype for love and social bonds is the mother-child interaction. The physiological pathways that permit social bonds are shared with parental behaviour, as well as birth and lactation. Our research in prairie voles revealed that two ancient neuropeptides and their receptors are foundational to the capacity to form pair bonds and also show defensive aggression. Those molecules are oxytocin and vasopressin. Both oxytocin and vasopressin are important to the social bond formation, but their functions are strikingly different.

Vasopressin is the more primitive of the two and is associated with adap-

tive functions that protect humans against dehydration and regulate blood pressure. Vasopressin has been associated with the neurobiology of anxiety, fear and avoidance learning. Both males and females synthesise vasopressin. However, in areas of the brain implicated in defensiveness and territorial aggression, vasopressin production is increased by androgens, and may play a central role in sex differences in the expression of aggression.

Oxytocin, in contrast, is associated with prosocial behaviours, including social engagement and the formation of social bonds. Oxytocin also may induce a sense of safety, reduce reactivity to stressors, block fear and increase trust. Processes that help to define mammals, including lactation and maternal behaviour are facilitated by oxytocin. Although both sexes synthesise oxytocin, in some cases estrogen increases sensitivity to the actions of oxytocin, favouring this peptide in females. Oxytocin was essential to human evolution, facilitating the birth, growth and nurture of our immature babies.

Oxytocin helps, directly and indirectly, to promote healing and restoration. For example, oxytocin has anti-oxidant and anti-inflammatory properties. Oxytocin also regulates the immune system and the highly protective parasympathetic, vagal branch of the autonomic nervous system. Vagal pathways, regulated by oxytocin, are



necessary for social communication and engagement through actions on the muscles of the face and head.

Furthermore, the autonomic nervous system regulates all of our internal organs, as well as the distribution of blood and nutrients throughout the body. Through effects on the autonomic nervous system, oxytocin regulates blood flow and oxygen to the brain, thus further supporting human cognition, culture and eventually civilisation.

Thus oxytocin-vasopressin effects on the autonomic nervous system are likely a critical component of the healing power of love. The autonomic nervous system is one portal through which the peptide systems and love may be accessed and influenced.

Oxytocin and vasopressin evolved from a common ancestral peptide. Oxytocin and vasopressin are similar in structure and interact dynamically with each other's receptors. However, for several reasons, these molecules are difficult to study. Their actions are adaptive, quickly changing and also

strongly affected by emotional context. Under conditions of safety, oxytocin promotes social engagement. But in a context of anxiety or fear, oxytocin may function like vasopressin, possibly by binding to vasopressin receptors.

Generally, oxytocin tempers fear and increases both trust and social behaviour. But in individuals who have a history of trauma or extreme stress, oxytocin may trigger the vasopressin system, enhancing fear and protective responses. The unique properties of the oxytocin and vasopressin systems allow these two molecules to be highly adaptive and support emotions such as love, but also jealousy and defensive aggression. The same novel properties that give oxytocin and vasopressin great power, also create serious challenges for understanding their functions.

The oxytocin-vasopressin system is constantly changing across the life cycle. Oxytocin affects the development of the brain, cardiovascular and immune systems. Recently, my colleagues and I have demonstrated that the expression of the gene for the oxy-

tocin receptor in voles is epigenetically tuned by early experience. Loving relationships, especially in early life can influence behaviour and physiology across the lifespan, in part through changes in the sensitivity of the oxytocin system. The absence of nurture may create a pattern of self-defensive and a sense of threat that could inhibit the capacity for love in later life.

The mechanisms through which love protects and heals are only now being discovered. Oxytocin influences sociality and social experiences influence oxytocin. Knowledge of the neurobiology of love helps to explain the exceptional reproductive success of humans and also our resilience in the face of fear and aggression. The emotional and physical health and longevity of our species, and perhaps our planet, depends on our capacity to understand and apply our knowledge of the biology of the love, especially in this time of trauma.

Early nurture epigenetically tunes the oxytocin receptor.

<https://www.ncbi.nlm.nih.gov/pubmed/30227351>

The Oxytocin-Vasopressin Pathway in the Context of Love and Fear.

<https://www.ncbi.nlm.nih.gov/pubmed/?term=Carter+love+and+fear>



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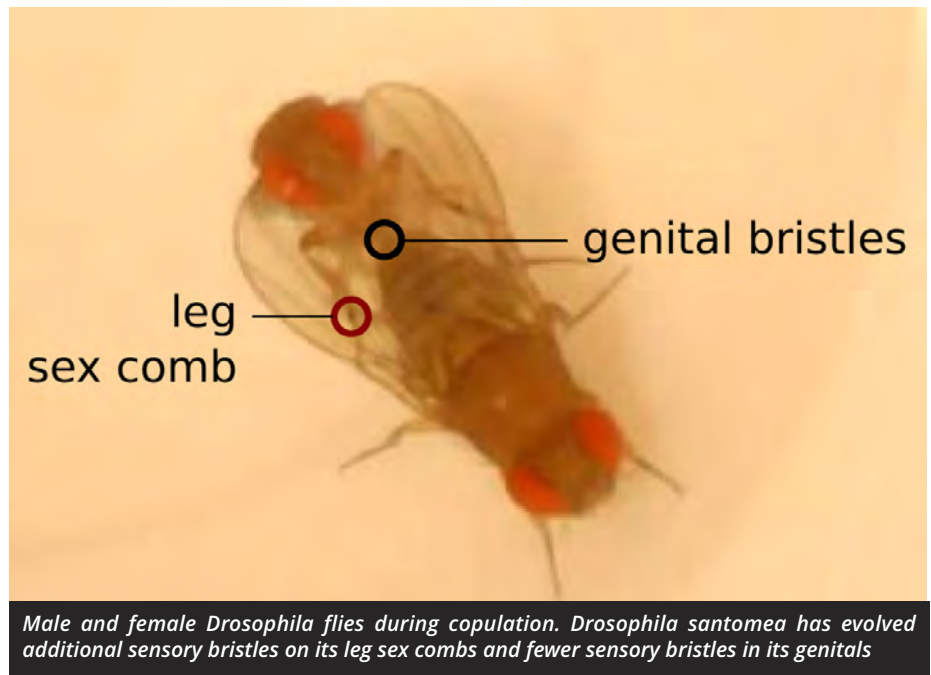
# Genetics: Understanding the origins of our biological traits

Virginie Courtier-Orgogozo, Directeur de recherche at CNRS explains an aspect of genetics that concerns understanding the origins of our biological traits

**M**illions of species inhabit our planet. Each species is characterised by a series of biological traits that enable organisms to live successfully in their ecological niches. Determining how these biological traits have evolved is fundamental to understanding biodiversity and the specificity of each species. Dr Courtier-Orgogozo and her team, from CNRS and the Institut Jacques Monod in Paris, use fruit flies as a model species and employ a cutting-edge multi-level approach, financed by an ERC Starting Grant, to decipher the fine mechanisms of evolution. Recently, her team made an important discovery about the contingency of evolution.

**“Our goal was to examine whether the loss of bristles on the genitalia and the gain of bristles on the leg could have originated through a single mutational event during evolution. Using advanced genetic mapping methods, we found that the loss of genital bristles is caused by mutations clustering around a particular gene called *scute*, which is very important for bristle development in insects.”**

We humans, when compared to our closest living relatives the chimpanzees, have bigger brains, a sophisticated language, longer hair on the head and fewer hairs on the body. To understand what makes us what we are, as human beings or as individuals, it is important to explore the origins of our traits. Observable differences



Male and female *Drosophila* flies during copulation. *Drosophila santomea* has evolved additional sensory bristles on its leg sex combs and fewer sensory bristles in its genitals

between species are due to mutations that accumulated in the DNA over multiple generations. For example, several millions of mutations occurred in our genome since our divergence from the chimpanzee lineage. Some of these mutations have no visible effects, while others have led to visible modifications of our brain, our eyes, or our predisposition to certain diseases. It is commonly thought that each species-specific trait evolved independently, through independent mutations. However, it is unclear whether several biological traits might co-evolve all at once due to a single mutation in the DNA.

As it is difficult to explore such a question in humans and chimpanzees, we decided to turn to two closely related

species of fruit flies, *Drosophila yakuba* and *Drosophila santomea*. These fruit flies are great organisms for research because we can easily cross them in the laboratory to produce hybrids, a process in which pieces of DNA from one species are introduced in the genome of another species, and thus explore the consequences of such a genetic mix. Furthermore, many genetic tools, including CRISPR-Cas9, can be easily used in the closely-related species *D. melanogaster* to examine the effect of particular mutations of interest.

*Drosophila yakuba* and *Drosophila santomea* live in Africa and they co-exist on the island of São Tomé, off the coast of Africa. These species diverged about one million years ago and their

DNA sequence is extremely similar. *D. yakuba* and other species have two sensory bristles on a particular region of their genitals whereas *D. santomea* has none. On the other hand, *D. santomea* has more sensory bristles on their forelegs than does *D. yakuba*. Both types of bristles are found only in males and appear to be used to grasp the female during copulation.

**“We humans, when compared to our closest living relatives the chimpanzees, have bigger brains, a sophisticated language, longer hair on the head and fewer hairs on the body. To understand what makes us what we are, as human beings or as individuals, it is important to explore the origins of our traits.”**

Our goal was to examine whether the loss of bristles on the genitalia and the gain of bristles on the leg could have originated through a single mutational event during evolution. Using advanced genetic mapping methods, we found that the loss of genital bristles is caused by mutations clustering around a particular gene called *scute*, which is very important for bristle development in insects. Without this gene, no bristles form and when the gene is over-expressed extra bristles form. In *D. yakuba*, the *scute* gene is highly expressed in the developing genitals, so that two bristles are formed in the genitals, and also in the developing forelegs so that eight to nine bristles are produced.

We tested the effect of our candidate mutations in *D. melanogaster* and we found that one mutation is particularly interesting. This mutation changes

only one letter in the DNA. It causes the *scute* gene to be expressed at a lower level in *D. santomea* compared to *D. yakuba*, and thus no genital bristles are formed. This same mutation increases expression of the *scute* gene in the developing foreleg, thus leading to extra leg bristles in *D. santomea* compared to *D. yakuba*.

Based on our results we, therefore, concluded that a single letter change in the DNA, which occurred during the evolution of *D. santomea*, has contributed to both a loss of genital bristles and a gain of leg bristles. It is important to note that the effect of this mutation is small: other mutations also contributed to the species difference in leg and genital bristle number.

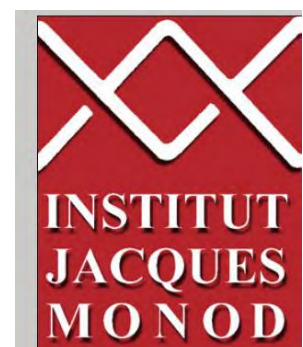
Our study shows that several traits can co-evolve all at once due to one mutation of a single letter in the DNA. The various traits that make us human may not have appeared individually one by one during our evolution. It is possible that some of our species-specific traits are just by-products of mutations that evolved for other reasons. Evolutionary studies such as ours are important to better understand the role of contingency in life evolution, past and future.

Further reading

Video abstract

<https://www.youtube.com/watch?v=37gVEkal560&t=1s>

Correlated evolution of two copulatory organs via a single cis-regulatory nucleotide change. Nagy O., I. Nuez, R. Savisaar, A. E. Peluffo, A. Yassin, M. Lang, D. L. Stern, D. R. Matute, J. R. David & V. Courtier-Orgogozo. Current Biology, 18 oct. 2018. Link DOI : <https://doi.org/10.1016/j.cub.2018.08.047>



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# Fighting Endocrine Disrupting Chemicals (EDCs) in our water: Where to begin?

Mikael Khan, Director of Technology at Arvia Technology lifts the lid on Endocrine Disrupting Chemicals (EDCs) in our water supplies

**W**ith such a heavy focus on plastic pollution in our water by the media, it's easy to ignore what lies beneath the surface.

Chemical waste seeping into the environment is becoming more difficult to tackle in modern times, and knowledge surrounding the subject is still developing.

The latest chemicals which have come under scrutiny for their potentially dangerous effects are known as Endocrine Disrupting Chemicals (EDCs), and they are found in an alarming number of everyday products. Up to now, they have been found in electronics, plastics, pesticides, cosmetics, toys, food containers and antibacterials.

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**“Along with exposing ourselves to dangerous chemicals through the use of everyday products such as pesticides and cosmetics, we are also inadvertently contaminating our water supplies. Contamination of water by consumers occurs through the excretion of waste material from the body, as a large majority of the products are not fully metabolised.”**

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Worryingly, approximately 1,000 chemicals have been reported to potentially have endocrine disrupting effects with many of these commonly found in various consumer products which are available to buy on the shelves.

The chemicals can mimic the body's natural hormones and 'disrupt' the endocrine system, which is one of two main regulatory systems in the body, consisting of glands that secrete hormones which are carried in the bloodstream around the body.

These hormones help to control bodily functions such as reproduction, growth, and development. EDCs are

exogenous substances that change the functions of the endocrine system, affecting the way an organism or its offspring reproduces, grows, or develops.

The list of health issues which the substances have been linked to is extensive and includes asthma, obesity, diabetes, reproductive abnormalities and infertility. Worryingly, some [research](#) suggests that EDCs could even be linked to cancer.

## Identifying the scale of the problem

The first step towards eliminating these chemicals from the production process is identifying which chemicals can be classified as EDCs.

Before any legislation can begin to provide companies with the necessary push to comply with EDC usage and disposal rules, the full extent of our exposure to EDCs must be realised. Luckily, steps are being taken in the right direction to identify EDCs.

The UN recently released a [list](#) of chemicals which had been through at least one “thorough scientific assessment”, having been identified as potential EDCs. The list comprised 45 substances under 18 chemical groups including phthalates, bisphenols and parabens.

Policymakers are also taking steps in the right direction with the introduction of regulations, such as [REACH](#) which calls for the registration, evaluation, authorisation and restriction of chemicals.

## Threatening our water supplies

On a day to day basis, we can reduce exposure to EDCs by avoiding certain cosmetic products, eating foods without pesticides and even making sure rooms are properly vacuumed and ventilated as chemicals are found in dust.





*Mikael Khan, Director of Technology at Arvia Technology*

## A holistic approach

With a problem as widespread as this, there needs to be a unified approach across the industry and from consumers. The eventual removal and replacement of dangerous chemicals is the obvious end-goal, however, in the meantime, steps must be taken to reduce our exposure to them.

The pharmaceutical industry has similar issues with wastewater effluents and it would be beneficial to see similar steps employed surrounding EDCs from all sectors.

Take-back and disposal schemes, green pharmaceuticals, eco-labels on packaging, compulsory prescription of pharmaceuticals with high environmental impact and awareness-raising are all being introduced to tackle the problem.

On a consumer level, education surrounding these dangerous chemicals is one of the most powerful tools to counteracting the problem. Fortunately, this information is steadily reaching the public sphere, with companies now offering products which are free from dangerous EDCs.

In terms of wastewater treatment, companies must use regulations as a starting point and look for further options to reduce the number of micropollutants entering the environment. It is reassuring to see the issue being raised by policymakers, putting it firmly on the political agenda.

The effects of EDCs on our bodies and the environment could be extremely damaging and wastewater treatment must form part of an industry-wide effort to counteract the problem. ■

## Mikael Khan Director of Technology

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Along with exposing ourselves to dangerous chemicals through the use of everyday products such as pesticides and cosmetics, we are also inadvertently contaminating our water supplies. Contamination of water by consumers occurs through the excretion of waste material from the body, as a large majority of the products are not fully metabolised.

For example, a large number of cosmetics are washed into our water supplies when we shower and then become difficult to treat.

In relation to the chemical industry, wastewater effluent from chemical manufacturing sites is also a major contributor to polluting the environment with EDCs. Wastewater discharged from chemical manufacturing sites along with pollution downstream from manufacturing plants has been subject to increasing attention.

Due to the various ways these contaminants are reaching our environment, river systems and waterways are now coursing with chemical waste. Often, trace levels of chemical waste are not removed by traditional treatment processes, meaning the same compounds can easily find their way into sources used for drinking water.

# Are environmental chemicals contributing to the obesity epidemic?

A group of experts from the University of California, Davis and the University of Southern California explain the extent to which environmental chemicals are contributing to the obesity epidemic

**O**besity is a metabolic disease characterised by excessive body fat that is defined clinically as having a body mass index (BMI) over 30. For the first time in human history, the number of obese and overweight people is greater than the number of those who are underweight. An estimated 1/3 of the world's population currently meet the clinical definition of obese, and it is predicted that approximately half the world's population will be obese by 2030.

Obesity is a major risk factor for numerous life-threatening diseases, including cardiovascular disease, cancer, and Type 2 diabetes, and in 2014, the global economic burden of obesity was estimated to be \$2 trillion. Given the significant health and economic impacts of obesity, there is an urgent need to identify the risk factors involved in the development of obesity. While caloric excess and sedentary lifestyle are classically identified as the main drivers of obesity, these two factors do not explain the recent dramatic rise in the global incidence of obesity.

Factors that are receiving increased scrutiny as potential risk factors for obesity are chemicals that interfere with the action of hormones that regulate metabolism and weight gain. These chemicals, which are referred to as "environmental obesogens", are

thought to promote obesity by interfering with metabolic homeostasis.

In support of the obesogen hypothesis, several human studies have demonstrated a positive association between exposure to environmental chemicals and obesity. For example, increased levels of dichlorodiphenyl-trichloroethane (DDT), a pesticide once widely used to control mosquitoes, have been linked to higher BMI in both children and adults in multiple populations around the world. More recently, maternal smoking or exposure to near roadway air pollution have been reported to increase the risk of childhood obesity.

While human studies are essential for assessing the feasibility of the environmental obesogen hypothesis, they do not establish that exposure to DDT, air pollutants, or other environmental chemicals, actually cause obesity. This is because it is difficult to tease out whether other factors that coincide with environmental exposure, such as socioeconomic stressors, may be the actual cause. However, studies of laboratory animals maintained in a controlled environment on a fixed diet have confirmed that at least some environmental chemicals can increase the risk of obesity.

Studies of animal and cell culture models are also providing insight as to

how environmental chemicals promote an obese phenotype. For example, environmental chemicals can increase fat storage capacity by increasing the number and/or size of fat cells, known as adipocytes. Cell culture experiments suggest that the industrial chemical tributyltin (TBT) increases the number of adipocytes by activating a receptor that promotes the differentiation of stem cells into adipocytes.

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**"Obesity is a global epidemic that affects adults, children and infants, and the rising incidence of obesity and its related diseases shows no signs of levelling off."**

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Consistent with these observations, experimental animal models exposed to environmentally relevant concentrations of TBT during development have increased fat accumulation in adipose tissues and the liver compared to control animals. Of concern, these studies suggest that the obesogenic effect of TBT is transgenerational, meaning that TBT may influence obesity risk in not only the individual exposed during development but also in the children and even grandchildren of the exposed individual.

Obesogens have also been shown to affect adipocyte function. Healthy adipocytes not only store energy but also produce hormones that signal throughout the body to control



appetite and energy balance. Air pollutants can interfere with both of these processes, increasing the body's ability to store energy while also decreasing the production of hormones important for metabolic health. The body also contains a special type of adipose tissue called brown adipose, which burns energy to create heat to maintain body temperature. This process is known as thermogenesis, and decreased thermogenesis has been linked to obesity in humans. Developmental exposure to DDT hinders thermogenesis in mice and decreases the expression of genes involved in burning energy.

The hypothalamus is a region of the brain that monitors and responds to changes in the body's hormonal and nutritional status to maintain metabolic homeostasis, and disruption of hypothalamic function can lead to obese phenotypes in animal models. Recent studies in mice have shown that exposure to air pollutants increases inflammation in the hypothalamus, which can interfere with hypothalamic function, and this effect coincides with increased body weight. Another animal study of the obesogenic effects of air

pollution linked increased obesity with decreased expression of hormone receptors involved in appetite regulation. Whether environmental chemicals alter the hypothalamus in other ways remains a critical data gap.

Obesity is a global epidemic that affects adults, children and infants, and the rising incidence of obesity and its related diseases shows no signs of levelling off. These alarming trends warrant research focused on understanding the relative contribution of environmental chemicals to the development of obesity, especially since exposures to environmental chemicals are modifiable risks. However, an effective public health strategy requires determining which of the tens of thousands of chemicals in the human environment have obesogenic activity. It may be possible to address this problem by leveraging cell culture models that express receptors that drive adipocyte differentiation or are implicated in controlling feeding behaviours. Chemicals found to activate these receptors in cell culture at environmentally relevant concentrations could then be studied in preclinical models to confirm obesogenic

potential at the organism level. In addition, it will be important to educate the public – especially pregnant women – as to the effects of environmental exposures on the disease risk in their child. Given the increasing evidence linking chemical exposure in utero to increased risk of obesity, it will be important to educate parents on the approaches for mitigating or reducing their exposure to suspected environmental obesogens before, during and after pregnancy, with the goal of reducing the risk of obesity in their children.

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# The European Commission takes action on endocrine disruptors: A call for a multidisciplinary network

Alberto Mantovani, Research Director at Istituto Superiore di Sanità reveals how the European Commission is taking action on endocrine disruptors (EDCs) and calls for a multidisciplinary network of cross-cutting silos

On November 7th 2018, The European Commission issued the Communication ["Towards a comprehensive European Union framework on endocrine disruptors \(EDCs\)"](#). The document originates from a prolonged (somebody would say lengthy, tiresome and timid) elaboration with the European scientific agencies (EFSA, ECHA), Member States and stakeholders and addresses the EU governance bodies (Parliament, Council, Economic and Social Committee, Committee of the Regions). Since the document illustrates the European perspectives for action, it may have a global resonance beyond the EU.

The Communication reiterates the importance of EDC-related issues for environment, health and consumer safety and points out the steps already achieved; the criteria for identifying EDCs under the legislation on pesticides and biocides, the progress of REACH implementation, specific provisions (e.g., ban of bisphenol A and the UV-filter 3-benzylidene camphor in baby bottles and cosmetics, respectively). Notwithstanding the apparent slowness of progress, the EU can claim the most advanced regulatory framework on EDCs worldwide.

The most interesting sections of the EC communication outline further

actions to improve the science-based governance of EDC-related problems. Below is a summary, flavoured with some of my own thoughts.

First of all, some main knowledge gaps are pointed out:

The impact of EDCs exposure on human health and ecosystems and the possible interplay with other risk factors for endocrine-related disorders (e.g., nutrition) or wildlife (e.g., climate changes).

This major issue would deserve more room for comments. Just one example is that human studies are increasingly used for risk assessment: a critical point is the measurement of internal exposure (biomonitoring) to the many non-persistent, yet widespread, substances which may make up the bulk of EDCs exposure in the general population, such as phthalates and bisphenols.

Taking these groups of EDCs, urine sampling is mainly recommended for exposure assessment; however, this may measure short-term excretion, rather than a toxicologically relevant internal dose. Blood, serum or plasma are not considered as ideal matrices by the majority of experts, but possibly because of limited knowledge on

factors influencing variability; data on deposition in hair or nails would be of interest, but are currently too limited to draw any conclusion. As a result, the exposure assessment of such important EDCs as bisphenols and phthalates (and others as well, like parabens etc.) currently relies on measurements in urine, which may not be the optimum solution.

The definition of a dose below which no adverse effect is expected to occur ("threshold dose level"); this is still controversial; at least for those EDCs that elicit genome expression changes by acting through nuclear receptors. The application of the threshold concept (which is widespread in toxicological risk assessment) to EDCs might be questioned especially when exposure occurs in vulnerable developmental windows. If the existence of a threshold is not supported by robust data, EDCs might be considered in the same way as mutagenic/genotoxic agents (substances able to cause transmissible changes to the cell genome), therefore, ranking amongst the "top concern" chemicals.

Moreover, the issue of mixture/cocktail effects is a priority for the toxicological risk assessment in general; it is particularly outstanding for EDCs, because of possible low dose effects

and of widespread exposure through environment and diet, to different substances that can hit the same endocrine pathways.

In order to realise the full potential of EU legislation actions, a horizontal approach for the identification of EDCs should be built across EU legislation domains, making avail of the criteria developed for pesticides and biocides. Therefore, up-to-date and consistent data requirements should be set in the different legislative frameworks.

**“The impact of EDCs exposure on human health and ecosystems and the possible interplay with other risk factors for endocrine-related disorders (e.g., nutrition) or wildlife (e.g., climate changes).”**

Also, more support should be given to data sharing and monitoring activities and further efforts should be devoted to the capacity building of risk assessors and risk manager through guidance documents and training. This process has to be EU-wide and inclusive, involving the EU Member States that had a limited presence in the EDCs debate till now.

Moreover, it is eventually recognised that debate and action must not be limited to the European Union or the “western world” (whatever it does mean): the document endorses bilateral co-operation and exchange of information on EDCs with global trade partners of the EU, including China. Taking this proactive approach, the search for such interactions with other major partners (Brazil, India, Russia, etc.) will likely emerge in the near future.

The section of top interest for governance is represented by the EDC-relevant Commission initiatives currently

being considered by the European Parliament and Council, or in the process of being implemented, that include:

- The proposed new Regulation on transparency and sustainability of risk assessment under EU food law, to increase trust in the regulatory process, including the assessment of high-concern substances;
- The European Plastics Strategy, to accelerate the substitution of substances of concern and promote recycling;
- The revised Drinking Water Directive;
- The New Deal for Consumers and the Goods package, to improve the enforcement of product safety requirements;
- The update of the legal framework on Occupational Safety and Health.

Interestingly, the European Commission remarks that the role of research is for a more sustainable, or resilient and living environment. Science is called to find solutions: the elimination of substances of concern in the production and end-of-life phases (the EU legislation will likely lead to banning or severe restrictions of substances with important uses in industry, agriculture, etc.); the development of safe substitutes, as well as safe and cost-efficient production technologies; eco-innovation for the prevention and remediation of environmental pollution from EDCs, looking also at the interface between chemicals, products and waste.

The risk assessment might have deserved more attention. The current legislative framework pivots on the identification and restriction of EDCs. But what about EDCs that already

entered environment and food chains? Some EDCs are also persistent and bioaccumulative substances, leaving a “legacy” throughout years and to the next generation(s), including the “emerging” polybrominated and perfluorinated substances. Tackling the EDCs legacy calls for resilience-aimed strategies, which have to be based on the definition of protection goals, hence on risk assessment.

While some points unavoidably deserve further debate or refinement, the Communication undeniably represents a step forward; it outlines valuable future actions to be implemented – hopefully – by the next Commission. As pointed out by the Communication and previously discussed in Open Access Government, minimising the EDC-related risks calls for a network of knowledge, and for the integration cross-cutting the silos of different scientific fields.



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# Access

## Challenges in creating open data policies for universities

Anne Mims Adrian, PhD, PUSH Open Data Project Manager charts the challenges in creating open data policies for universities

As government agencies and private foundations are increasingly requiring public access to scientific publications and to the supporting research data as terms of their grants, universities struggle to meet these new requirements.

Though open data practices at universities seem to be driven by funders' requirements, university leaders and researchers also recognise the benefits of open access and open data. They see the values of data as accelerating the pace of discovery, facilitating transparency, confirming of scientific results, increasing collaborations, building faculty and universities reputations and credibility, and supporting education.

Although universities recognise these benefits of open access and open data, they also have some concerns and hesitations. At the centre of this conflict is the

protection of intellectual property – who owns the work and research conducted at universities. Since the passage of the Bayh-Dole Act of 1980 which gave rights to universities to own inventions and research obtained through federal dollars, U.S. universities have been increasingly motivated to protect research and intellectual property for potential income opportunities, especially with those prospects that may yield big profits through patents and royalties. Prior to the passage of the Bayh-Dole Act, federal research funded contracts assigned inventions to the federal government.

The current intellectual property paradox for universities arises from the protection of potential profits that can be absorbed back into universities and the growing beliefs in the benefits to the public from open access to research findings and research data. Universities are asking how can they provide for open access and open





## EDUCATION & YOUNG PEOPLE

the current university research culture, incentives, and practices are generally poorly suited to support open data.

The struggle between open data and intellectual property protection lies within the confusion of who owns the data. The confusion begins with data ownership policies. Sometimes data ownership is specified within intellectual property policies, but most often data ownership is ambiguous. And for some universities, data ownership is not mentioned in their policies at all. Confounding the issue for some is the de facto mode of practice of faculty deciding how they use the data, despite policies stating that the data and work by faculty are owned by their parent universities.

Because of funders' requirements and public expectations toward access to research findings and research data, universities are reacting with additions to infrastructure and support that will provide for open access and open data. However, to get to the bottom of this, we must affect culture and practice. And we know that culture and practice reflect policies. To change policies that will 1) help universities comply with funders' requirements of open access and open data and 2) create a notion of public access to publicly funded research, we must evaluate our current policies.

Before developing open data policies, universities need to examine and clarify current data ownership policies. From their examinations, policies can be developed that can balance the protection of potential profits and providing for the greater good. ■

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data and still protect universities' work – particularly those works that may create profits for universities.

Furthermore, universities current systems reward faculty for publishing research reviewed by their peers. Many researchers fear that with this kind of data others may scoop their work and publish similar analyses before they have had ample time to publish all findings. On the other hand, faculty are discovering that when they share their data, their work is cited more, and the possibility of collaboration is increased. Balancing sharing research data and protecting universities' and intellectual property for faculty is a challenge, but a challenge worth working through.

While some universities are evaluating their current open access and open data policies, hiring additional librarian support, and creating data repositories,



# Reconciliation

## Reconciliation in a higher education context: Tensions and challenges

Dawn Zinga, Associate Professor and Chair at the Department of Child and Youth Studies at Brock University explores reconciliation in a higher education context, by detailing the tensions and challenges in this area

In August 2017, I wrote about how Canadian institutes of higher education were taking up the Truth and Reconciliation Commission's calls to action. Almost a year later, higher education contexts continue to face tensions and challenges in addressing those calls to action. There has been much talk of how to address the calls and some policy changes, but it is clear that there are a lot of tensions and challenges around the implementation of any changes. Lakehead University offers an example of how those tensions and challenges can be

expressed. The university's response to Recommendation 28 was to ensure that all law students were provided with opportunities to better understand Indigenous peoples and the law by weaving Indigenous content throughout the law curriculum. However, in practice, there appear to be challenges with the implementation of significant changes. Angelique Eagle-Woman was hired by Lakehead University as the first female Indigenous law school dean in 2016 but resigned citing systemic discrimination and racism in 2018. This unfortunate situation

underscores the difference between a surface response to the calls to action and meaningful action.

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**"The conundrum facing higher education is how to proceed to address the calls when institutions are having difficulty being able to recognise how the very structures of the institutions are getting in the way."**

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Universities and colleges are struggling to address the calls to action and to understand what reconciliation means. Indigenous scholars Marie



Battiste, Jan Hare, Jackie Ottman and Dwayne Donald spoke eloquently at the 2018 Congress of the Humanities and Social Sciences about reconciliation within a higher education context. Each of them remained committed to the conviction expressed by the Commission that education will be pivotal in putting Canada on the road to reconciliation. Battiste spoke about the importance of decolonising and how everyone has been “marinated in Eurocentrism” and that the tenets of Eurocentrism that are characterised by superiority, hegemony and a monopoly over all other knowledge systems, stand in the way of reconciliation. Battiste speaks about cognitive imperialism and how every Canadian student has been a victim and beneficiary of the same education system that has exposed them in Eurocentrism and cognitive imperialism. These act as some of the greatest barriers to reconciliation and the serve to blind people to the colonialism embedded throughout education at all levels.

Dwayne Donald agrees that it is difficult to accomplish much when the very institution that claims to want to take steps towards reconciliation gets in the way when tensions arise. He argues that part of the problem is the tendency within higher education contexts to take shortcuts by attempting to make changes without examining the embedded colonialism. When change is implemented in those contexts, tensions quickly rise and the response to those tensions is to reassert “colonial terrain”.

Jackie Ottman also spoke to the hidden curriculum and unconscious codes that are triggered by attempts to meaningfully address the TRC. She stated that while the Royal Commission on Aboriginal Peoples issued its report in October 1996 and offered over 400 recommendations, the TRC’s 94 calls to action has engendered a more lasting response. However, she warns that the weight of addressing those calls to action within higher education contexts could not be left to Indigenous students and scholars to do all the heavy lifting, but that non-indigenous students and scholars needed to walk alongside and share the weight and the work. Jan Hare agreed with her colleagues and calls for a continued commitment to reconciliation that is grounded in an understanding of everyone’s roles and responsibilities.

**“Universities and colleges are struggling to address the calls to action and to understand what reconciliation means.”**

The conundrum facing higher education is how to proceed to address the calls when institutions are having difficulty being able to recognise how the very structures of the institutions are getting in the way. Most institutions are implementing policies and directives, but not doing the hard work of exploring what it will mean to actually implement those policies and directives. The end result is window dressing without any meaningful change or a resurgence of colonialism and a return to the status quo that hides behind

claims of cultural inclusion or returns to pathologising Indigenous students and scholars.

Reconciliation requires an examination and understanding of what has happened and how current structures, systems and attitudes/biases that are conscious or unconscious continue to uphold colonialism and Eurocentrism. University mission statements can include commitments to Indigenisation but without a meaningful examination of what that term means and an appreciation that decolonisation is the first step and that such commitments will fail to produce any significant change, other than putting a new face on a continued inability to engage in reconciliation.



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# Widening options for adult learners

Alison Watson, Programme Leader for BA (Hons) Business at Arden University provides insight into widening education options for adult learners

There is a diffused perception amongst mature adults that higher education is for 18-year olds and not for them. Often I hear: “I never thought I was good enough to go to university, and now here I am”.

As an academic, hearing this fills me with both sadness and hope. The adult learning market is challenging and complex due to fears from adults believing that they are not good enough to gain a degree. Frankly, for a lot of potential adult students, this is not the case. After some consideration, it became evident to me that this feeling of isolation and alienation from the higher education sector should be addressed.

**“It is clear that there is some work going on to draw more mature students into higher education, and at the same time maintaining the momentum to provide an established provision for the entire marketplace. As competition for this market increases, higher education institutions will surely be required to “up their game” and focus on how to capture these students and retain them.”**

There have been a number of studies conducted to ascertain how to widen participation and access for all students. The UK government is encouraging smaller bite-sized courses and accelerated degrees, whereby students can learn with flexibility online, thus enabling them to continue in their employment. The government has also introduced maintenance loans helping students to fund their education and increase their social mobility within society.

2012 was declared the year of the MOOCs (Massive Open Online Courses), whereby short courses were available online. These types of courses do have their benefits and expose adults to “taster” sessions on particular subjects. It is anticipated that those who

undertake to study a MOOC will one day enrol onto a higher education course.

Higher education itself has also been through significant change over the years, in particular with relation to student funding and market entry of alternative higher education providers being made easier.

Whilst the latter may challenge conventional institutions offering traditional campus-based teaching, alternative providers offer differentiation in their courses. Take, for example, Arden University and other online higher education providers; these institutions offer adult learners alternative routes into higher education through online and blended learning, thus enabling students of all ages to obtain their degrees.

It is important to ensure that access to higher education is not for a privileged minority and that everyone has the freedom to pursue their education if he or she wishes to. Institutions are devoting more resources to the admissions and marketing functions to send a clear message to potential students, that message being that higher education is accessible, that their participation is important and that the outcome of degrees will be skills development. Allocating resources to certain segments is also a strategy being employed and reaching out to minority communities may encourage more adults to apply for university places.

The government is also focusing on alternative provisions for adult learners and have made a significant commitment to establishing 3 million apprenticeship placements by 2020. These apprenticeships will offer adults the opportunity to develop their skills vocationally and at the same time, they will work towards a qualification. For those students who have been out of education for a while, this mode of delivery



works well and builds confidence through the knowledge of having support from their company and at the same time, the coaching and mentoring advice from academic staff.

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**“It is important to ensure that access to higher education is not for a privileged minority and that everyone has the freedom to pursue their education if he or she wishes to.”**

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It is clear that there is some work going on to draw more mature students into higher education, and at the same time maintaining the momentum to provide an established provision for the entire marketplace. As competition for this market increases, higher education institutions will surely be required to “up their game” and focus on how to capture these students and retain them.

### About the author

Alison Watson is Programme Leader for BA (Hons) Business at [Arden University](https://arden.ac.uk/).

She’s an expert in marketing, human resource management, international business and student recruitment. She has been operations and project manager in the retail sector for 14 years and completed an MBA via distance learning whilst working full time to become a lecturer. Alongside working for a number of higher education institutions, she specialises in bespoke learning and training packages. ■

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# 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 (Cll), 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.

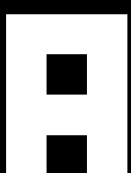
The concept of "Competitive Knowledge" is central to the Institute's philosophy. Our interpretation is clear: we always start from the conditions and needs of those around us before adding the value and benefit that is demanded. We have pursued this approach in real-life situations – with striking results. 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.

# Mind the word gap: The difference in poor children's language skills

Mary Hartshorne, Head of Evidence at I CAN explains the difference in poor children's language skills when it comes to closing the word gap

Take a walk along any street and you'll hear the children's chatter. Children use language in play to make sure they get what they need or want, to say how they feel and to share the news. However, there is a very real difference in the type of chatter you hear in different parts of the country or even in the same city. A child growing up in a very deprived part of Manchester, for example, will talk very differently to one growing up in a more affluent area. In fact, research had shown there's a huge difference.

A landmark study carried out in the mid-1990's by Betty Hart and Todd Risley coined the phrase the '30 million word gap'. Over a period of two and a half years, they recorded the language in the homes of three-year-old children. They found that a child in a family on benefit heard 30 million words less than a child in a professional family.

The recordings also showed that children in poorer families spoke around four times fewer new words per day. A [more recent study](#) found that as well as the words a child says, there are dramatic differences in the number of words children in different social economic groups understand. This difference is there by the time children are 18 months old.

This is worrying given the fact that children need good language skills to be able to learn to read, to do well in school, to make friends and manage their behaviour. Children's language at age five is the single most important factor in [predicting literacy at age 11](#) – more important than behaviour, peer relationships, emotional well-being, positive interaction and attention.

## UK government policy on language

Speaking in July 2018, [Damian Hinds](#) expressed concern about the number of children finishing their reception



Mary Hartshorne, Head of Evidence

year still not able to talk in sentences. He announced his ambition to cut the number of children starting school with poor language in half over the next ten years. Closing the word gap is the top priority in the UK government's social mobility action plan and the funding to ensure this happens is being realised through the Department for Education's programmes in the home, local services and early years settings.

It's a while since we have seen children's early language development so high on the political agenda. This is great to see. Given that we have known about these language differences for quite a long while, it is also long overdue.

## 'The Word Gap'

'The Word Gap' is a neat way of describing the problem; it has been picked up and used to really highlight a pressing need. However, its simplicity also raises some issues, including the ones detailed below.

Firstly, it's not just words. Studies have shown that other aspects of language also lag behind – children's ability to talk in sentences, their understanding of instructions and how well they can put their thoughts into words to tell someone what has happened. For children living in disadvantaged areas, all these skills can be behind what is expected. A study carried out in Stoke on Trent, for example, found that in some areas [64% of children starting school](#) had language that was behind age expectations.

Secondly, it's not just talking to young children that matters. Hart and Risley also noted that there were differences in the amount of interaction happening in different homes i.e. the amount parents and children talked together. In fact, we now know that it's the [‘back and forth’ conversations](#) that are the most important in developing young children's language: talking with and not to children.

My third point is that this gap in language skills as children start school is critical but without support, the gap stays there, right through school. One study in a secondary school in a deprived area of Sheffield found that 83% of students had poor language, a very different situation to a school in a nearby affluent area. Recently, Oxford University Press published [‘Why closing the word gap matters’](#), reporting on a survey of over 1,000 teachers; 40% felt students lacked the vocabulary to access learning and over 60% of secondary teachers felt the gap between students with poor word knowledge and their peers was increasing.

Finally, closing the word gap is an admirable mission but for many of the 30 million children, this is unlikely to happen. [7.6% of all children have developmental language disorder \(DLD\)](#), they have a language difficulty which won't get better by itself. It's important to differentiate these different groups of children. Children with DLD need specialist support, very different to what's needed to close the word gap.

### Solutions to ‘The Word Gap’

That brings me onto the good news! There are solutions.

Some areas have taken up the challenge and tackled the word gap at a city-wide level. In Stoke-on-Trent, the *Stoke Speaks Out* initiative has been running for over a decade. Over that time the number of children starting

school with delayed language has reduced from 64% to only 39% of children.

Given that children learn most vocabulary in the home, other areas have looked specifically at improving parental engagement. In Merseyside, the children's centre team in Kirkby work closely with the local speech and language therapy team and with health visitors to make sure parents get the support they need as early as possible. In [their evidence](#) to [Bercow: Ten Year On](#) (a national review of provision for children and young people with SLCN), they explained how this approach had significantly increased the number of children reaching early learning goals.

In schools, specifically targeting language through a small group intervention can give children with the delayed language the boost they need to narrow the gap between them and their peers. I CAN's [Talk Boost](#), for example, can improve children's language by up to 18 months after a ten-week intervention.

There is also a recognition that change needs to happen at a strategic level. It's encouraging to see Public Health England working closely with the [Department for Education](#) to develop tools for assessing children's early language, training for health visitors and a pathway to ensure children's difficulties are picked up on early and supported. It's also encouraging to see recognition of the need for behaviour change in the way that people view children's early language.

### Children's language – the key to social mobility

There is no easy solution but recognising that children's language is key to social mobility is one huge step in the right direction. Seeing the intention for solutions strategically, in schools and readily available for children and their families makes the next step seem achievable. ■

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# 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) <sup>(1,2)</sup>.

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.

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**“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.”**

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## 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 <sup>(3)</sup>. 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. <sup>(1,2)</sup>

## 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 priorities for education and training in the Irish state

Open Access Government explores the priorities for education and training in the Irish state, following the appointment of Joe McHugh TD as the Minister for Education and Skills, replacing Richard Bruton TD in the role during October 2018

The Department of Education and Skills is a government department of the Irish state who is responsible for the areas of education and training. Their mission is to facilitate individuals through learning in order for full potential to be achieved so that people can play their part in Ireland's social, cultural and economic development. <sup>(1)</sup> It's interesting to note that education and training provision is a policy area that is also covered by the Department of Business, Enterprise and Innovation who believe that: "skills needs are identified and met through alignment of education and training provision." <sup>(2)</sup>

## A short profile of Joe McHugh TD

Joe McHugh TD was recently appointed the Minister for Education and Skills, replacing Richard Bruton TD in the role on 16 October 2018. Richard is now Minister of Communications, Climate Action & Environment. <sup>(3)</sup>

In terms of Joe McHugh's background, he was born in 1971 and is the second eldest of five children. His father Denis was a builder and farmer and mother Mary worked as a district nurse and today, the family continues to live at Claggan, Carrigart. Joe previously served as Government Chief Whip and Minister of State at the Department of Culture with responsibility for Gaeilge, Gaeltacht and the Islands up to October 2018.

In July 2011, he was appointed as Co-Chairperson of the British Irish Parliamentary Assembly and during July 2012, Deputy McHugh was elected as Chairperson of the Joint Oireachtas Committee on the Implementation of the Good Friday Agreement. Deputy McHugh was re-elected to Dáil Éireann as a Fine Gael TD for Donegal back in 2016. His career prior to that included his time as a geography and maths teacher at Loreto Convent

in Letterkenny from 1993-95 and teaching A-level economics in Dubai between 1995 and 1996. He also worked as a Community Youth Worker in Glenwood, Letterkenny between the years of 1996-1999. <sup>(4)</sup>

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**"I want an English language education sector that we have confidence in and which provides a quality education to students coming to Ireland to learn English. Those working in it are integral to the quality of that provision."**

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## National Strategy on Education for Sustainable Development 2014-2020

Let's now turn and look at some of the Minister's recent work around education and training. One example is when he attended the National Forum on Education for Sustainable Development (ESD) in late November 2018, where he launched the mid-term review of the ESD Strategy. The Review acknowledges the significant amount of work that has taken place since the launch of the Strategy in 2014 and details the resulting action plan up to 2020.

As new curricula are developed at all levels, key ESD principles are being embedded and integrated into the Strategy. As such, the role of educators is vital to success and teacher training programmes are also being developed and revised and to take on board ESD themes and elements. Minister McHugh said at the event that: "Educating our students about Sustainable Development is key to ensuring responsible citizenship into the future".

Certainly, there has been much cross-sectoral collaboration in relation to the implementation of the strategy and of the UNs Sustainable Development Goals (2015)



and the Irish Aid Development Education Strategy. Minister McHugh expressed his own thoughts about this: “The great work being done by our stakeholders to deliver on the aims of the Strategy, highlighted in the review, are acknowledged and appreciated. This collaboration has been key to the successes to date”.<sup>(5)</sup>

### The English language training sector

In early December 2018, Minister for Higher Education, Minister Mitchell O'Connor underlined that the example at Grafton College Dublin, exposed weaknesses in the availability of fair terms and conditions of employment in parts of the English language training sector.

The proposed International Education Mark (IEM) is a key component of the Irish Government's policy for the English language training sector by providing a quality framework for the provision of education to international learners travelling to Ireland to learn English.

The Minister stated her priorities for the sector: “I want an English language education sector that we have confidence in and which provides a quality education to students coming to Ireland to learn English. Those working in it are integral to the quality of that provision.

“No-one wants to see English language teachers not being paid or being deprived of their employment rights. The situation that has emerged at Grafton College where teachers have been left without salaries is completely unacceptable.”<sup>(6)</sup>

### Irish-Medium and Gaeltacht education

Finally, let's look at another promising area of education policy, which takes us back to October when the Minister for Education and Skills, Joe McHugh T.D launched a new Masters in Irish-Medium and Gaeltacht Education (M.Ed.) in Mary Immaculate College, Limerick. This teacher education programme is another step in the implementation of the Gaeltacht Education Policy 2017-2022 and encompasses part of a greater national plan in the Irish State to tackle issues concerning the supply of teachers.

Speaking at the launch, Joe McHugh T.D. provided his own insights into this important step forward in Irish education policy, which brings this article to a conclusion on a positive note: “It is great that specific entry criteria for Irish language proficiency are required to gain a

place on this postgraduate programme. This programme constitutes a wonderful opportunity to provide different options for participants who wish to gain expertise in the field of Gaeltacht and Irish-medium education. Through this programme, students can undertake a Postgraduate Certificate, a Postgraduate Diploma or a Master's in Education through the medium of Irish.

“I hope that this new postgraduate teacher education programme will go from strength to strength in the future. I have provided funding under the Gaeltacht Education Policy 2017-2022 to register 30 participants every year, which should result in 5 cohorts of 30 teachers/principals over a 6-year period.”<sup>(7)</sup> ■

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- 7 <https://www.education.ie/en/Press-Events/Press-Releases/2018-press-releases/PR18-10-19.html>

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# Addressing uncertainty to make infrastructure safer

Arturo González addresses the need to make infrastructure safer as it continues to experience an increasing rate of deterioration

Some infrastructure is experiencing a fast rate of deterioration as a result of poor design/construction/maintenance or more demanding loads than anticipated, and many buildings, transport, and energy infrastructure are getting close to the ends of their design lives. There is a need for assessing the safety of these structures, i.e., to check that the probability of the structural response falling beyond an established threshold for a given period of time is acceptable. This calculation involves defining a number of input variables that include loading as well as structural properties such as moduli of elasticity, material strength, geometry, boundary conditions, etc.

In a high-level assessment, these variables will be defined by a range of values with a probability of occurrence. Multiple combinations of these input values lead to output responses that become more scatter as the input variables are less well-known, and as the modelling errors increase. Training in Reducing Uncertainty in Structural Safety (TRUSS), is a €3.7 million Marie Skłodowska-Curie Innovative Training Network (ITN) composed by six Universities, 11 companies and 1 research institute from five European countries, joining forces to identify, quantify and reduce uncertainties associated with the probability of structural failure. For this purpose, 14 fellows are recruited to be trained with the right combination of transferable and research-related skills, and to

conduct research in specific projects while being exposed to academia and industry, different culture environments, disciplines, and sectors, that will prepare them for dealing with the challenges of an ageing infrastructure stock.

When assessing structural safety, the engineer uses mathematical models consisting of a set of input variables including material properties, load characteristics, environmental effects and geometric dimensions, and a set of derived outputs, i.e., stresses, displacements, damage, etc. There is a degree of uncertainty associated with the models given that they are imperfect idealizations of reality and that their input variables may not be exactly known. Therefore, it is useful to distinguish between epistemic (due to lack of knowledge and data) and aleatory (due to natural random variability) uncertainties. In this way, one can assess how much of the total uncertainty could be potentially further reduced by refining models or by taking more measurements, and how much could be quantified, but cannot be reduced.

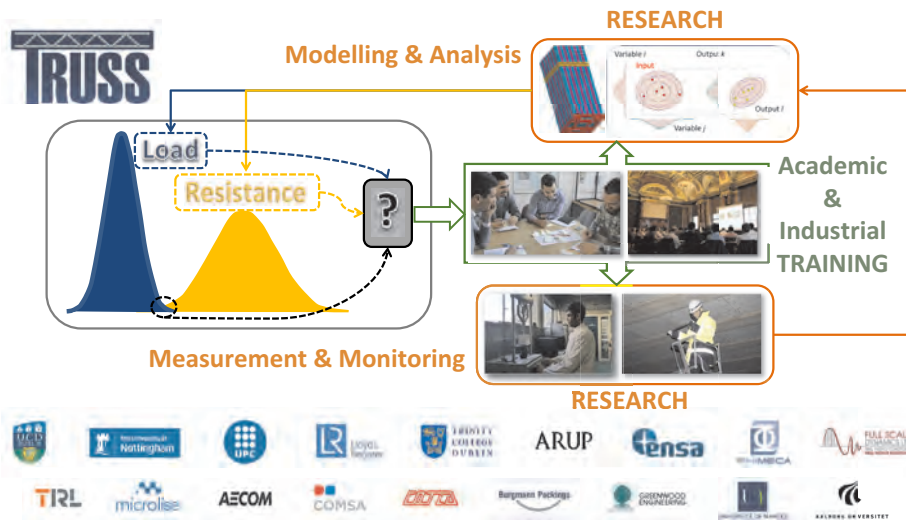
There is a degradation of reinforced concrete structures due to corrosion of steel, with global annual costs estimated in around \$2.5 trillion. The use of braided Basalt Fiber Reinforced Polymer (BFRP) rebar offers potential performance benefits as it is not subjected to corrosion. However,

before designing a structure with BFRP, it is necessary to be fully aware of the inherent uncertainty associated with its mechanical properties. TRUSS quantifies this aleatory uncertainty in a systematic manner, via numerical analysis, tensile and fatigue lab tests, and  $\mu$ CT scanning.

Uncertainties can be inherent to a material property, but they can also be related to the measurement of observations, i.e., the errors in the estimation of in-situ concrete strength with respect to the true strength, introduced by the indirect measurements of a non-destructive test applied to an existing building. This is an epistemic uncertainty that TRUSS aims to reduce via a new screw pull-out testing method that provides better quality data.

Structural geometry can present deviations from the original drawings due to human errors, construction defects or deterioration. For an existing structure, TRUSS reduces this epistemic uncertainty via unmanned aerial vehicles, which are able to overcome difficult-to-access areas and to obtain a full 3D reconstruction at a relatively low cost. This 3D geometry can be imported into a finite element model for structural assessment purposes.

A high-level method of assessment requires to bring measured data into a model by some kind of optimization technique (i.e., finite element updating) to resemble reality. These models



can then be used to predict a wider range of future scenarios than those contemplated during the testing or monitoring period, although a degree of uncertainty remains due to modelling errors. The sources of these modelling errors can be both epistemic and aleatory. TRUSS reduces these errors for two highly nonlinear cases, such as the response of a ship unloader to a moving trolley and the response of submerged free-standing nuclear racks subjected to an earthquake, via model refinement with the help of field and lab measurements.

It must be noted that the reduction in uncertainty is limited by a lack of knowledge or data to predict the exact structural behaviour and by the difficulties in increasing the model complexity at the expense of new variables that often cannot be measured. When measuring a structural response, such as strain, for monitoring purposes or for quantifying modelling errors, sensors are traditionally placed only on a few discrete points, typically spaced wide apart to cover a significant portion of the structure. As a result, the response of in-between measurement points is opened to an uncertainty that new developments in distributed optical fibre sensors by TRUSS overcome with high-spatial resolution continuous readings.

Questions arise in infrastructure management on when and how to inspect the structure that TRUSS answers with advanced probabilistic methods, taking the probability of detection of damage, the probability of the evolution of damage, the structural reliability and the life cycle costs into account for assessing fatigue failure in a marine environment. If the mathematical models corresponded to complex structures, the calculation of the remaining life or reliability using Monte Carlo simulation can be computationally very expensive. In order to overcome the latter, TRUSS proposes the far more efficient surrogate models (i.e., kriging). TRUSS also contributes to addressing the uncertainty associated with total life cycle costs in the field of pavements, by building a relationship between fuel consumption and road condition based on field data from vehicle sensors.

With more than one million bridges in Europe, including 100000 railway bridges over 100 years old, recent bridge failures are a sign of a trend that will continue unless the infrastructure is monitored on an ongoing basis. Infrastructure managers need to combine high-level methods of assessment prioritised for key critical infrastructure, with other simpler and faster methods allowing for a preliminary

assessment of a major proportion of the infrastructure stock on a frequent basis. TRUSS employs numerical simulations, lab and field tests to investigate the performance of five structural health monitoring methods in establishing whether a bridge has experienced damage (i.e., a stiffness loss) from its response to traffic. These methods are based either on (i) indirect bridge measurements from sensors mounted on a vehicle crossing the bridge, or on (ii) direct measurements from sensors attached to the bridge that, (ii-1) extract vibration-based damage sensitive features, (ii-2) monitor the influence line, (ii-3) update a Bayesian Belief network, and (ii-4) apply bridge weigh-in-motion concepts, with the purpose of damage detection. These monitoring methods provide a preliminary assessment that will be cost effective if they demonstrate that the structure is in good condition, whereas more advanced methods of assessment will be deemed to be necessary in the case of unsatisfactory preliminary results.

The TRUSS ITN project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No. 642453.



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# Manufacturing: The strength of innovation in the UK

Simon Edmonds, Deputy Executive Chair and Chief Business Officer, Innovate UK writes about the strength of innovation in the UK when it comes the manufacturing sector

Working at [Innovate UK](#) provides a unique insight into the strength of innovation in the UK and the appetite of our businesses, large and small, to develop new products and services. Since our organisation's inception in 2007, we have supported innovation across 8,500 organisations, which has created 80,000 jobs – nine for each company we've worked with. Three-quarters of the companies we work with are small businesses, across all sectors of the UK economy.

As part of [UK Research and Innovation](#), Innovate UK is a key delivery partner for the government's modern [industrial strategy](#), which identifies the four Grand Challenges to put the United Kingdom at the forefront of the industries of the future. These are artificial intelligence (AI) and data, ageing society, clean growth and the future of mobility. This is creating new opportunities for businesses and sectors across the UK and are areas the government feels that the UK can punch above its weight.

Our support is available to businesses across all economic sectors, value chains and UK regions. With a strong business focus, we drive growth by working with companies to de-risk, enable and support innovation.

Looking in particular at our support for manufacturing and materials companies, our aim is to enable these businesses develop transformative capabilities that are flexible and resource-efficient, ensuring leading-edge products are manufacturing-ready and that the value of UK manufacturing and materials innovation benefits the UK economy.

There are some key ways we are working with businesses to achieve this goal, which are detailed below.

The [Faraday Battery Challenge](#) is a really good exam-

ple. It is breaking new ground because it offers for the first time a coordinated programme of competitions across research, innovation and scale-up funded with a £246 million investment through the government's [Industrial Strategy Challenge Fund](#). It will, therefore, draw the very best of the UK's world-leading research into commercial technologies and put UK businesses at the forefront of electric vehicle battery development.

Also, relevant here is the work of the [High Value Manufacturing Catapult](#) which through its world-beating seven technology and innovation centres across the UK brings expertise and equipment for use by business and to help bridge the gap between academia and business.

Throughout 2017/18, we have invested up to £151 million in our sector-based and open programme competitions for businesses. This latest competition is one of our broad competitions aimed at encouraging collaborative business-led innovation in our key sector through grant funding. All successful proposals must demonstrate that they will improve business growth and productivity or create export opportunities for at least one UK SME involved in the project.

For over a decade, our funding has been helping UK manufacturers to grow and innovate. Take, for example, high-tech engineering company [Lontra](#) who is building a new manufacturing facility in Warwickshire for its innovative industrial compressors and to create new jobs.

The business developed its Blade Compressor® – a revolutionary new design for an air compressor – with the support of Innovate UK. Our support for the development of the Blade Compressor came through a number of projects. This included initial feasibility



*Simon Edmonds, Deputy Executive Chair and Chief Business Officer*

studies, development of a prototype, and investigating its use in industrial areas, including power generation and food processing.

Manufacturing businesses across the country have a long association with the [Knowledge Transfer Partnership scheme](#), which supports UK businesses to innovate and grow.

KTPs enable businesses to bring in new skills, and the latest academic thinking, to deliver an innovation project of commercial benefit in a three-way knowledge-based partnership between them, an academic or research organisation, and a suitably-qualified graduate.

An excellent example is the work of specialist machinery manufacturer [Cygnet Texkimp](#) and the [University of Manchester](#) who have created a cutting-edge machine to support the next generation of fuel-efficient cars and aeroplanes.

The 3D Winder is the world's first robotic winding machine capable of laying carbon fibre to make complex, lightweight composite parts for industry.

Through the Knowledge Transfer Partnership, the Northwich-based company brought in PhD graduate and composites academic, Dr Yan Liu, to develop this technology to work with more complex and curved shapes. Following the success of the partnership, Yan was offered a permanent role at Cygnet Texkimp's R&D centre.

An important area of Innovate UK's work with businesses across the UK is helping them reach out internationally to partners and opportunities. We do this for example through our missions, helping companies find prospective partners and markets abroad.

It is, therefore, very encouraging to report successes from previous missions we've run, such as the excellent news that advanced materials business [Versarien](#) has signed a major deal with a South Korean partner after being part of an Innovate UK mission to the country.

The Cheltenham-based specialist in 2-dimensional materials has entered into a collaboration agreement with AXIA Materials Co. The relationship was formed during an Innovate UK global business innovation programme visit to South Korea.

I would urge companies wishing to innovate to visit [our website](#) to see how Innovate UK is there to help and support them innovate and grow their business. ■

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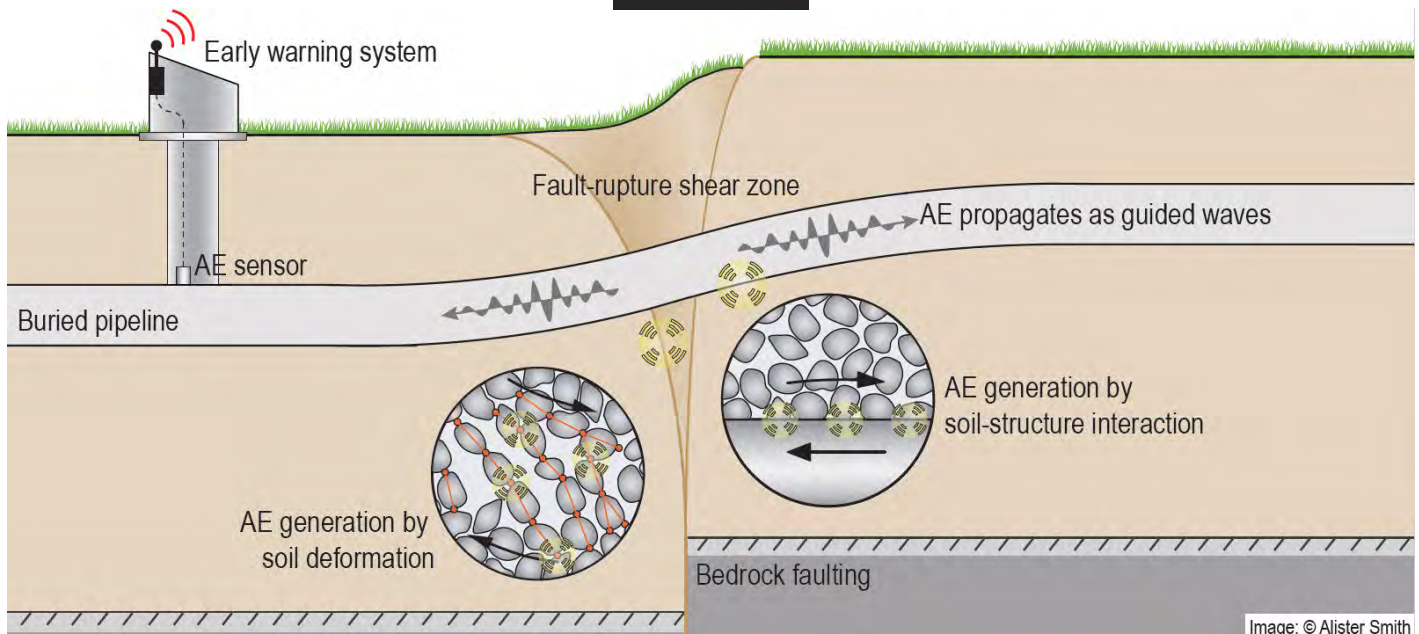


Image: © Alister Smith

**Figure 1. Illustration of the Listening to Infrastructure monitoring concept. The example shows a fault-rupture deforming a buried pipeline. AE is generated by soil deformation and soil/structure interaction, which propagates as guided waves along the pipeline to the monitoring sensors. The monitoring system interprets the AE and sends a warning to decision makers via telemetry.**

# Listening to Infrastructure: Early warning systems for infrastructure deterioration

Dr Alister Smith, a UK Engineering and Physical Sciences Research Council Fellow based at Loughborough University, is developing novel infrastructure health monitoring technologies

Infrastructure is vital for society – for economic growth and quality of life. Existing infrastructure assets are rapidly deteriorating, the rate of which is accelerating with increasing pressures from climate change and population growth (e.g. flood levels, weight and frequency of trains) and new-builds are being designed and constructed to withstand largely unknown future conditions. Society, therefore, urgently needs to be better prepared to face these grand challenges by exploiting technology to increase understanding of asset deterioration and improve decision making and asset management.

Infrastructure networks cover vast geographical areas to transport people and products (e.g. water, oil and gas) and hence are critical lifelines

which society heavily relies on. These assets rest on or are buried inside soil (i.e. underground), which exposes them to potential damage from ground movements. Deterioration can have catastrophic economic, environmental and societal consequences and the service of entire networks can be terminated.

A transformation in infrastructure health monitoring capability is urgently needed to enable targeted and timely interventions, which should provide: high accuracy and reliability, high spatial and temporal resolution, remote and real-time functionality and alerts and early warnings.

Moreover, it is essential that the technologies are low cost to ensure they can be widely distributed across

entire infrastructure networks. The Listening to Infrastructure research programme aims to provide this transformation in monitoring capability by monitoring acoustic emission (AE).

## Acoustic Emission (AE)

Proportions of the energy dissipated during the deformation of particulate materials (i.e. soil) are converted to heat and sound. The high-frequency (>10kHz) component of this sound energy is called acoustic emission (AE). AE monitoring offers the potential to sense particle-scale behaviours that lead to macro-scale responses of granular materials.

AE is widely used in many industries for non-destructive testing and the evaluation of materials and systems; however, it is seldom used in geotech-



nical engineering, despite evidence of the benefits, because AE generated by particulate materials is highly complex and difficult to measure and interpret.

AE is generated in soil bodies and soil/structure systems through a suite of mechanisms including: inter-particle friction; particle contact network rearrangement (e.g. the release of contact stress and stress redistribution as interlock is overcome and regained); the degradation of particle asperities; particle crushing; and friction at the interface between the soil and structural element.

## Why AE?

Instruments and techniques to monitor geotechnical assets do exist, but none is without technical limitation or prohibitive cost. Conventional approaches typically provide localised information on deformations or groundwater at discrete time intervals. Nascent technologies are beginning to provide continuous measurements (e.g. fibre optics), but to retrofit hundreds of thousands of kilometres of assets with these sensors would be prohibitively expensive. Continuous monitoring is essential as it provides information on the condition of assets throughout their life-cycle and allows any changes to stability/integrity to be communicated in real-time.

AE has the potential to increase our understanding of how assets are deteriorating, which could lead to improved design approaches and to extract more information about asset condition than existing techniques do: not only deformation behaviour, but also, for example, changes in stress states, transitions from pre- to post-peak shear strength (i.e. deterioration of soil strength) and using correlation techniques it will be possible to locate

the source of AE to target maintenance and remediation activities.

AE sensing will also provide real-time warnings which will enable safety-critical decisions to be made to reduce damage and lives lost because of geotechnical asset failures. The number of asset monitoring locations required per unit length to achieve sufficient spatial resolution will be less than other monitoring techniques and at a significantly lower cost.

## Listening to Infrastructure

The Listening to Infrastructure research programme is developing continuous, remote, real-time AE monitoring systems that can be distributed across geotechnical infrastructure assets (e.g. buried pipelines, foundations, retaining structures, tunnels) to sense soil and soil/structure interaction behaviour and provide early warnings that will enable targeted and timely interventions.

The aim of the current UK Engineering and Physical Sciences Research Council Fellowship is to develop analytics to interpret the AE generated by geotechnical infrastructure assets, enabling implementation in autonomous monitoring systems. If we can listen to geotechnical assets with intelligent sensors - analogous to a stethoscope being used to listen to a patient's heartbeat - we will be able to provide information on the condition of infrastructure and early warning of deterioration in real-time.

Figure 1 shows an illustration of the Listening to Infrastructure monitoring concept: the fault-rupture is propagating upwards from the bedrock through the soil body and intersecting the buried pipe, which can lead to tensile or buckling failure and hence poten-

tially catastrophic consequences.

## Progress and Future Work

Novel methodologies to interpret AE generated by deformation of soil bodies and soil/structure interaction and by seepage-induced internal erosion, have been developed using an extensive programme of controlled element and full-scale laboratory tests, including experiments performed at the world-leading buried infrastructure research facility at Queen's University, Canada, in collaboration with Professor Ian Moore.

In addition, new understanding of how AE propagates in buried infrastructure is enabling source location methodologies to be developed. Plans are in progress with project collaborators to perform full-scale field-testing with in-service assets, which will demonstrate performance and benefits in intended applications and environments and progress the research through Technology Readiness Levels to support exploitation.



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# The challenges of a new rail signalling system in Denmark

Danish Minister for Transport, Building and Housing, Ole Birk Olesen, explains the introduction of a new rail signalling system for the country, including the challenges when it comes to the successful deployment of ERTMS

On October 21st, 2018, in Denmark, we delivered on a first major stepping stone in our country-wide deployment of the new signalling system in Denmark. Here, the first railway line in Denmark equipped with ERTMS was commissioned for commercial passenger service. The line is now in regular operation and has been running without major concerns since commissioning. Part of the works undertaken includes the retrofitting of ETCS onboard units on a fleet of rolling stock consisting of Siemens Desiros and Alstom LINT-trainsets. This means, that we in Denmark now have a fully functional infrastructure system and that the supplier is able to deliver adequately in this context.

The overall background is that the Danish rail-sector suffers from a legacy signalling system, which puts capacity utilisation and punctuality highly at risk. The system is built around interlocking equipment, which dates back to the 1950s and 1960s. Today, approximately every fifth passenger delay is due to signalling-related errors. Thus, replacement of the existing signalling system is a necessary investment.

In 2009 the Danish Parliament decided to fund a total replacement of all signalling equipment on the entire Banedanmark railway network with the common European signalling standard ERTMS (European Railway Traffic Management System), level 2, baseline 3, whereby in-cab signalling equipment replaces external signals, as we know them today.

The new signalling system is expected to bring about large savings related to traffic management as well as renewal and maintenance, a uniform and high safety level across the entire network, higher punctuality and in this connection fewer signalling related delays,

and a foundation for increased capacity and speed. Moreover, trackside and onboard equipment may be supplied by any of the ERTMS suppliers as all equipment is fully interoperable, making the supply market more flexible, independent and competitive.

However, total replacement is not just a simple task. Admittedly, it has proven to be more difficult than originally anticipated.

The key to successful migration is building a fleet of rolling stock capable of running on both new and legacy systems. That requires retrofitting of the existing fleet of rolling stock with state-of-the-art digital equipment, which is not an easy task. Nevertheless, retrofitting the current fleet of rolling stock is key to a smooth transition from signals of the electro-mechanical era to the new IT-based ERTMS signals. Retrofitting of the existing rolling stock as such dictates the speed with which we can proceed with our deployment of ERTMS.

## The challenges in the successful deployment of ERTMS

The complexity involved in migrating to a digital, in-cab signalling system is greater than foreseen for certain train types (e.g. IC3) than others. The complexity of the train types depends on the characteristics of the trains, as well as on a general mapping of train age, the number of series, variation in overall technical specifications such as engine power, etc. In order to reduce risks in fitting the more complex train types, we have designed the fitment plan in a way, where fitment of the complex train types builds on the learning from the fitment of the less complex train types (e.g. Lint and Desiros).



Image: © Niels Hougaard

The successful deployment of ERTMS depends on various stakeholders. While the European Commission is responsible for the technical specifications, the product itself is delivered by the rail manufacturing industry, which consists of a considerable matrix of firms, where the cooperation required has proved to be difficult.

Getting the signalling design and supply industry to work together in the production of compatible products has been a tough task. Add to this both hardware and software factors and the progressive implementation of updates and changes, one can see that it needs a strong coordinating body to keep this under control and to ensure that all suppliers follow the same course. Moreover, physical deployment requires both infrastructure managers and railway undertakings to invest in ERTMS. The railway undertakings' involvement and collaboration are of substantial importance since they contribute with expert knowledge regarding the rolling stock.

In addition, in Denmark, we are not only planning to replace our existing signals, but we are also planning to electrify our main lines and run electric train operations by the middle of the 2020s. The combination of

these three major investments entails many interfaces and complicates the transition from old to new signals and from diesel train operations to electric train operations.

It is my hope that the rail industry will take advantage of the opportunities that follow from the investments and again become competitive with other modes of transport. ■

### **Ole Birk Olesen**

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# Improving the rail commuter's experience: Does government policy reflect the voice of the customer?

Steve Brockway from Maru/edr explores the UK government's rail expansion policy and asks if it's really improving the customer experience for commuters, or should rail companies be listening more to the voice of the customer?

The UK government's intention to expand and improve the railway network is apparent in multiple policies; HS2, Crossrail and even the recent upgrades to Waterloo station are a reflection of the ongoing strategy to build more capacity and a better network for passengers and train companies alike. Even with cuts on a local level, the investment in our rail network looks set to continue with £48 billion of funding announced in November 2017.

This rapid expansion plan is outlined in the 'Visions for the Railways' released by Transport Secretary Chris Grayling in November 2017. However, there is a very real feeling that the policy of expanding the network is leading to more building works, related delays and changing schedules for commuters, begging the question, are these expansion works really addressing the problems of regular commuters?

## Is the vision for railway policy improving the customer experience for commuters?

Improving the customer experience is all about listening to and acting upon customer feedback to design strategies that will actually improve things for your customers. If you take a look at social media, you'll discover that the number one customer issue is the availability of seating and is especially true if you look during disruptions or strikes. You'll notice a pattern behind the complaints as people report their frustration at a lack of information and poor facilities.

It could easily be argued that the government policy of increasing capacity is directly addressing many of the problems that commuters are experiencing. However,

strikes frequently lead to resentment from consumers towards train companies and their employees, with 52% of social media posts monitored during the recent week-long October strikes displaying negative or very negative sentiment towards them. In fact, just 3% of commuter comments analysed by Maru/edr were positive about the strikes at all, with almost all of these being praise of individual employees during the disruption and how the customer experience was managed throughout them

## Keeping up with changing commuter habits

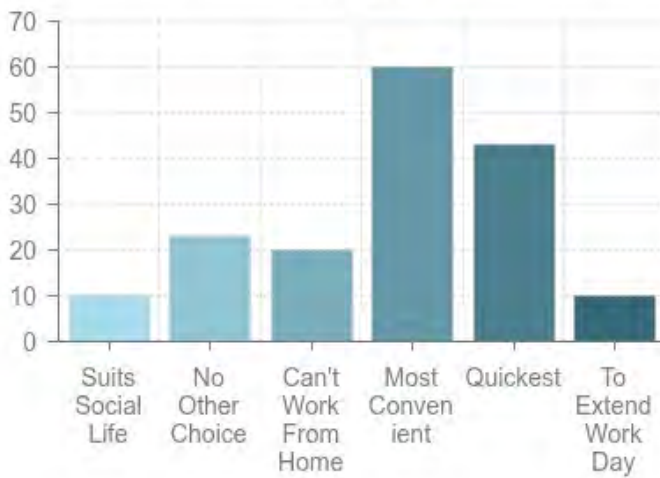
68% of regular commuters spend £1,000 a year or more on train travel – with 30% of these spending over £2,000 annually. With commuting being such a key source of revenue, it's important to keep up with changing commuter habits and expectations in a bid to deliver a compelling customer experience.

People travel by train for an extent of reasons, mainly thanks to the convenience (60%) that rail journeys still afford yet interestingly recent results also suggest one quarter (25%) actually enjoy travelling by train and another 10% claim it suits their social life.

However, Maru/edr data also shows that almost 1 in 4 train commuters travels by rail as they have no other choice (23%) or that they cannot work from home (a further 20% of commuters).

Interestingly, data from The Office for National Statistics (ONS) suggests that over 1.78 million employees in the UK now class their home as their primary working location. In fact, between 2005 and 2015, the number

**Why People Commute (%)**  
People Who Commute More Than Once Per Fortnight



Enjoy Train Travel

maru/edr

of people regularly working from home increased by over 240,000 and a similar increase of 260,000 between 2015 and 2017 suggests that the pace of this increase is set to continue.

Whilst it could be argued that train companies have a captive audience who will persist with train travel through railway improvement works, the growing trend of working from home could present a tangible threat to their future if more and more companies adopt flexible working policies.

Train companies will use insight to serve the needs and changing expectations of commuters who want facilities that work for them. It would appear that building increased capacity and providing reliable and fast Wi-Fi would result in more people commuting on a more regular basis – 10% of regular rail passengers already state that they currently travel by train to extend their working day.

Interestingly, this data also suggests other reasons why people are still commuting with 13% saying that train travel allows them to socialise more and 30% actually enjoy train travel.

## Does the vision for the railways match passenger demands?

Whilst it may appear that the additional works will increase delays and so directly work against the

demand for punctual and reliable train services, the improvements themselves are targeted at increasing capacity and improving facilities. Most of the major concerns of passengers relate to their experiences as customers, with vocal complaints about increasing rail fares on routes where passengers are regularly unable to get a seat or access basic Wi-Fi.

Government policy does appear to be targeted at solving most of the major concerns raised by passengers and regular commuters, but the most glaring omissions appear to be the availability of internet connections and improving the information available to people about train delays and issues. It means that embedding the voice of the commuter into the heart of train operations is the only way to ensure a successful franchise delivering for both customers and rail ministers. ■

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# How the UK's airports should navigate disabled access

Hilary Stephenson, Managing Director of Sigma explains how the UK's airports should navigate disabled access

When it comes to disability, access and accessibility are often conflated. By definition, access is the *opportunity* to approach a place or service, while accessibility refers to the *quality* of being able to do so.

Everybody, regardless of their personal circumstances, should have a high-quality of accessibility within all aspects of their life. This includes airport experiences, which are playing an increasingly key role in many people's workdays and leisure time.

However, according to the [Civil Aviation Authority](#) (CAA), over 10% of travel hubs across the UK are currently below par in this respect. Recent examples of this include when [Justin Levene](#), a paraplegic man, had to drag himself through a London airport after his wheelchair failed to arrive on the baggage carousel.

Despite the fact that an increasing number of airports are deemed to be 'very good' in terms of accessibility, shortcomings – such as the one mentioned above – continue to reoccur. This indicates that the aviation sector needs to do more to improve its disabled access.

Findings from our recent '[Accessible Spaces](#)' report support this. The research highlighted a severe lack of accessibility awareness within a variety of venues across the UK's tourism industry – including airports. It found that a quarter of businesses could not accommodate for those in wheelchairs, and a third of companies were unable to accommodate for those with cognitive impairments like autism.

To resolve this situation, the industry must completely revise its approach to accessibility. This involves going



back to basics; identifying each airport's exclusive aspects and taking the appropriate action to ensure both their online and physical presence are disability-friendly.

With this in mind, let's identify the outstanding issues currently holding UK airports back and how they can be addressed to become more accessible to all.

## Pinpointing the problems

In order to start resolving an airport's accessibility issues, management must identify what these problems actually are. These can range from inaccessible websites to poor customer service. From there, appropriate action can be taken to overcome these obstacles.

Currently, the most common issues faced by disabled individuals within UK airports are as follows:

- Excessive waiting times for assistance.
- Lack of staff awareness - inexperienced online chat attendants, untrained desk staff or unhelpful social media responses.
- Poor web accessibility – sites not designed with disabled users in mind.
- Prioritising cost saving over high-quality service for disabled passengers.
- Poor recording and reporting of performance data – this helps airports identify what is working well and what needs to be improved.

These are clearly good starting points for airports to interrogate, but each travel hub is different. The most effective way of addressing areas for improvement is to analyse individual feedback received annually from governing bodies such as the CAA. This will provide a better understanding of what specific improvements need to be made.

However, regardless of how well an airport's accessibility is perceived, if a venue is given any suggestions on ways it could further improve its offering, these should not be considered optional modifications. Instead, they should be seen as basic necessities.

## Leading the way

Great examples of airports that have taken this feedback on board and consequently improved their accessibility are Edinburgh and Liverpool.

Edinburgh's 'Very Good' rating was particularly impressive given that just two years ago its accessibility was considered 'Poor'. The airport implemented Neatebox's [Welcome app](#) to facilitate great user experience for disabled passengers. This allows users to request visits to the airport prior to travel and sends the venue an overview beforehand of that person's condition, including top tips to aid interaction with them. It has also built up close ties with local disability groups to ensure its offerings are in line with their needs and expectations.

Liverpool, on the other hand, was recognised for providing disabled travellers with an efficient, timely service throughout the year, with 88% of people rating their experience as excellent or good. This involved staff being on hand to assist individuals throughout their entire airport journey if they required and ensuring minimal waiting times for those people requiring wheelchairs upon arrival. Overall, the measures have enabled disabled travellers to experience the same seamless journey as every other passenger.

Their efforts highlight what airports should be doing – but what is the best way to go about making changes for those that are lagging behind?

## What needs to be done?

To ensure the rest of the UK's airports get up to scratch, they must improve both their physical and online presence.

This must be more than just a box-ticking exercise to meet various accessibility guidelines. Instead, it requires airports to ensure every aspect of the venue and business caters for all passengers, regardless of their ability.

One way of checking this, which works for interiors and web design, for instance, is by questioning whether a service or offering is fit for those with loss of mobility, hearing, sight, or those with various behavioural disorders. If the answer at any point is a "no", it is clear something needs to be done to rectify this.

## Physical modifications:

In terms of airport interiors, there are countless modifications that can be made. As a basis, a few worthwhile considerations are outlined below:

- Become wheelchair friendly – have a dedicated desk for mobility enquiries, ensure there is wheelchair access throughout the airport, dedicated disabled parking in a range of airport car parks, wheelchair accessible telephones and good toilet facilities.
- Provide services for travellers with cognitive impairments – enable pre-visits so individuals can familiarise themselves with an airport, create quiet zones and implement a lanyard scheme so staff can identify those who may need additional support.
- Adapt for those with visual and hearing impairments – install induction loops throughout, adapt payphones for those with hearing aids, provide braille signs and be guide-dog friendly.
- Provide better staff training - enrol employees on to [courses](#) to ensure they are properly trained to understand and deal with customers of ranging abilities.

## Digital inclusion:

However, it is pointless working to improve an airport's physical accessibility if its website does not mirror this level of inclusion. For this reason, user-friendly web design is key.

Here are a few inclusive features that should be incorporated to improve web accessibility:

- Text size – make sure this is adjustable.
- Visual effects – make these optional by allowing users to turn them on and off where required.
- Links – make clickable links larger than surrounding text.
- Video accessibility – ensure videos are closed-captioned or there is a sign language version available.

The [Web Content Accessibility Guidelines](#) are also a great point of reference for web design as it specifically

outlines how an airport's websites can be made more accessible.

When designing accessible websites, it is also important to note that attempting to amend previously excluding features should be avoided. This will never be as effective as tailored coding – hence, designers should start from scratch and focus on accessibility from the outset.

While the above changes may seem costly and time-consuming, they are essential to ensure everyone has equal access to everything an airport has to offer.

## Preparing for taking off

Going forward, there needs to be a complete revision on how airports approach accessibility. This involves re-analysing the foundations of their services and offerings to ensure they accommodate for every traveller.

Not only will this improve the quality of life for the 13.9 million UK residents who have some form of disability, but it will also enable the aviation sector to benefit from the increasingly valuable purple pound – which currently equates to £250 billion in the UK alone.

However, above everything else, airports must remain mindful of the fact that inclusion is not just a commercial obligation, but also a moral imperative. It is not enough to simply allow disabled travellers access to an airport, these venues need to be entirely accessible to them as well. By adopting this mindset, the UK's aviation sector may better cater for all. ■

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**“Currently, one of the most common issues faced by disabled individuals within UK airports is excessive waiting times for assistance.”**







# The rise of sustainable aviation fuels

Dr Simon Blakey, Senior Lecturer in Mechanical Engineering at the Low Carbon Combustion Centre, The University of Sheffield explores the rise of sustainable aviation fuels

**G**lobally, in the last 24 hours more than 90,000 flights and more than 6 million people have been lifted up, high in the air and have been transported in thin, cold air in which we could not survive and landed safely at their destination and the only thing concerning us is how long the queue will be at the baggage carousel.

To allow this remarkable feat to happen, jet fuel is moved through the global distribution system at over 7,000 litres a second throughout the day and night. This colossal volume of aviation fuel requires an efficient,

quality controlled and a well-managed delivery system. Above all, a safety-first approach is required throughout the system, from production to use.

The civil aviation sector has spent much of the last 60 years optimising the design of aircraft and engines to reduce aviation fuel consumption and lower CO<sub>2</sub>, noise and NO<sub>x</sub> emissions. The sector has had significant success in this undertaking, however, during this period the composition and properties of aviation fuel have been taken as a constant. This has effectively meant that the sector has been optimising hardware around a range

of average, or worst-case fuels available. The use of these fuel sources represented no change on the sources used for gas turbines since the beginnings of the jet age and as such was the “Jet A-1 everybody knows”, based on accumulated experience.

The sector is now challenging itself even further and has imposed upon itself a range of emissions targets to further reduce its environmental impact: An average improvement in fuel efficiency of 1.5% per year from 2009 to 2020, a cap on that aviation CO<sub>2</sub> emissions from 2020 essentially being carbon-neutral growth and a

reduction in net aviation CO<sub>2</sub> emissions of 50% by 2050, relative to 2005 levels. The achievement of such goals is requiring a continuation of technical and flight management improvements and attention has turned to the fuel used for flight. Moves towards fuels from a non-fossil sources are increasing and are supported globally by the establishment of market-based measures by UN-ICAO through the CORSIA scheme, which is currently voluntary for UN member states. Importantly, this is the first sector to place upon itself such stringent import targets and many member states are scaling up the production of fuels from a range of different sources to allow this to be achieved.

**“To allow this remarkable feat to happen, jet fuel is moved through the global distribution system at over 7,000 litres a second throughout the day and night. This colossal volume of aviation fuel requires an efficient, quality controlled and a well-managed delivery system. Above all, a safety-first approach is required throughout the system, from production to use.”**

Significantly, many of these more novel fuels offer significant advantages to the engine emissions performance, they have a higher energy density and consequently a lower CO<sub>2</sub> emission for an equivalent energy release, they are cleaner burning and produce significantly less soot emission. The debate concerning the uptake of such fuels should be extended to cover these other, non-CO<sub>2</sub> related benefits which will undoubtedly improve the

case for the use of such fuels. In fact, such considerations lead to the conclusion that the fuel ought to be considered as an enabler of such future gains in emissions reduction, rather than a bought in the commodity to achieve flight and should be considered fuel and engine as one, a whole system which needs optimising.

The approval of fuels for use is, like the provision of fuels, a safety-first approach, which seeks to ensure that any candidate fuel is technically suitable for use in existing aircraft through the ASTM D4054 process. The University of Sheffield and the research staff at the Low Carbon Combustion Centre are involved in a wide range of alternative fuels research activities specifically related to aviation and the approval of alternative fuels. The team has been working on the technical assessment and the suitability technical suitability of candidate fuel since the early 2000s and has gained experience in analysing and assessing any fuel both using established techniques used for conventional fuels and new research-based techniques, where the established techniques are challenged by the novel fuel composition.

This work is continuing with a range of International and European funded projects develop a better understanding of the impact changes in fuel chemistry have on the performance of airframes and engines. Along with partners around the globe, The University of Sheffield is continuing to conduct research both for the aviation

and increasingly for the automotive sector. If you would like to find out more about our work please get in touch.

## Biography

*Since 2004, Simon has worked as part of the growing team at the Low Carbon Combustion Centre at the University of Sheffield focusing on the technical suitability of alternative and conventional fuels and fuel system hardware for the aviation sector. Simon is Director of the Low Carbon Combustion Centre, Working Group Leader on Alternative Fuels for ECATS, a European Network of Excellence for the development of sustainable fuels for the Aviation Sector and part of the University's Energy 2050 initiative. Simon manages a number of aerospace industry-facing research programmes focusing on the technical suitability of alternative and conventional fuels, as well as methods for the assessment of the performance of fuel system engine hardware.*



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# The future of cities in the UK: A vision for 2030

Cllr Judith Blake, Chair of Core Cities UK and Leader of Leeds City Council sheds light on a new report, *Cities 2030 Global Success, Local Prosperity*, which details a vision of UK cities in 2030

For more than two decades, Core Cities UK has been urging successive governments to fulfil the potential of UK cities and city regions by giving them greater freedoms and controls.

Our new report, *Cities 2030 Global Success, Local Prosperity* begins by imagining a future where our policy ideas have been implemented and the UK of 2030 is reaping the benefits of economic and social growth.

In a dozen years' time, the UK's economy is geographically rebalanced, our state is smarter and joined up, and our citizens are more engaged in democracy. Our places are benefiting from improved infrastructure,

including HS2 Phase Two, and we have recovered from the economic shock of Brexit and are helping the UK seek out new markets and opportunities.

Our workforces are better skilled and educated, and our cities continue to be diverse, welcoming and friendly places to live, work, study and visit.

We don't think this is an overly optimistic, unrealistic vision. Elements of what we propose have been achieved in other places around the world and national and local government working together has delivered real change, including through devolution, helping us take positive steps on this journey.





## THE BUILT ENVIRONMENT



*Cllr Judith Blake, Chair of Core Cities UK and Leader of Leeds City Council*

We should model this on the International Labour Organisation which, almost a century ago, set a new social contract for fair pay, working conditions and social justice. Cities should be at the heart of this vision, but we recognise that other places matter as well.

The relationships between cities and the places around them are complex and interdependent. We need to do more to understand these connections and formulate a policy that will build a better, more inclusive future for all. ■

*Core Cities UK 2030 Global Success Local Prosperity is available at [corecities.com](http://corecities.com)*

For example, the UK's cities have been extremely successful at getting people into work and have much higher youth employment levels than some other European cities.

Our ideas are achievable and the rewards for success are huge. We can generate almost £100 billion for the UK economy every year if the government adopts our 'productivity package' bringing ourselves up to the economic average of other comparable European cities. Put into perspective, that is roughly the size of the UK education budget or the size of our country's motor vehicle industry.

Our new report also sets out how we can begin to build a new contract between the state and the people it serves as Brexit becomes a reality.



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# Epidemiological interactions between rural and urban populations and the consequences of urbanisation

Romola Davenport and Richard Smith from the University of Cambridge explore epidemiological interactions between rural and urban populations and the consequences of urbanisation

Today, urban populations almost always have higher life expectancies than their rural counterparts, because cities provide better access to health facilities, clean water and sanitation and because urban dwellers tend to be richer. However, this pattern is a very modern one. Before the early twentieth-century rural populations were almost uniformly healthier than urban ones. Indeed, in the centuries before c.1770, European cities were characterised by death rates so high that their populations would have imploded without a reliable stream of rural migrants. Some scholars have argued that this 'urban graveyard' effect imposed an upper limit on the levels of urbanisation and therefore, economic growth that those pre-modern societies could sustain because cities imposed such a drain on the populations of their rural hinterlands.

For rural migrants to towns, the health costs of immigration were high. Before the twentieth century, towns were characterised by much higher levels of infectious diseases, especially gastrointestinal diseases, as a consequence of inadequate sanitation and so-called 'crowd' diseases that relied on high population densities for transmission.

For those born in towns, these diseases took their greatest toll in childhood, when diarrhoeal diseases were most lethal, and when many diseases were encountered for the first time. For urban-born adults, the disadvantages were not so great, because those who survived to adulthood had already encountered and developed some immunity to many of the most dangerous urban diseases. Migrants, however, were in an immunological sense akin in some ways to young children. Many rural migrants came from areas where diseases, such as measles and smallpox were rare, and they often arrived in cities with no immunity to these diseases.

The consequences of these differences in disease exposure in rural and urban areas are strikingly illustrated in the case of smallpox. Before the introduction of vaccination c.1800, smallpox was the single most lethal disease of eighteenth-century Britain, accounting for up to 10% of all deaths in southern England and up to 20% in the north.

In eighteenth-century London, smallpox was pre-eminently a childhood disease, with deaths concentrated amongst children under seven. However, there was a second bulge of smallpox deaths amongst young adults, primarily when young migrants

arrived for the first time in London. Although probably taller on average than their urban-born peers and healthier than the rural populations they left behind, these young economic migrants contributed to high urban death tolls.

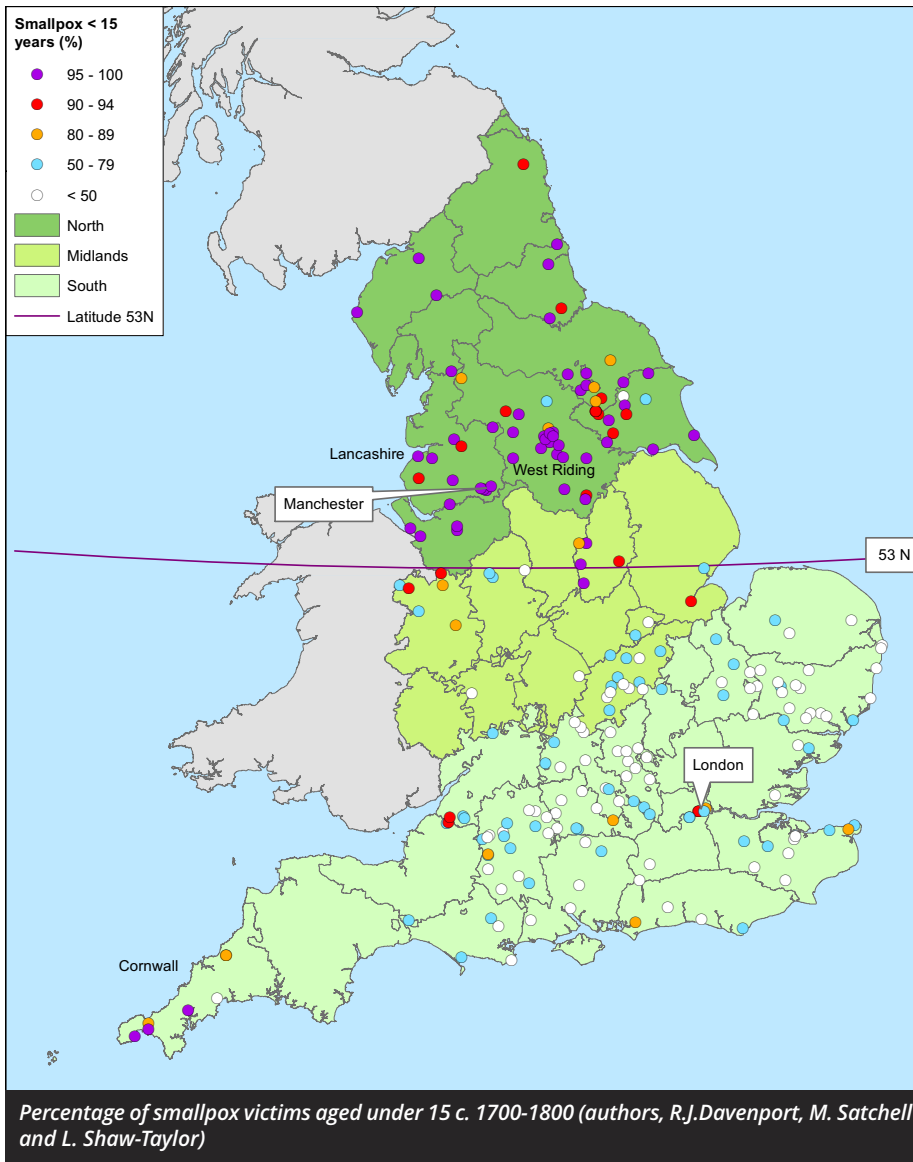
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**"For rural migrants to towns, the health costs of immigration were high. Before the twentieth century, towns were characterised by much higher levels of infectious diseases, especially gastrointestinal diseases, as a consequence of inadequate sanitation and so-called 'crowd' diseases that relied on high population densities for transmission."**

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Before vaccination, the dangers of smallpox to rural migrants to towns depended on the extent to which smallpox patterns differed between towns and their migrant hinterlands. In southern England, smallpox was a rare epidemic disease outside the largest cities and many rural dwellers survived to adulthood without infection.

However, in northern Britain smallpox circulated as a childhood disease throughout rural as well as urban areas. As a consequence, very few migrants died of smallpox in northern towns because they were already immune. This north-south difference



accompanied industrialisation. As a consequence of vaccination, changes in urban breastfeeding habits and other as yet unidentified factors, mortality in British cities had fallen by the early nineteenth century to the point where urban populations could reproduce themselves and cities acted to brake, but not to reverse population growth. Further improvements in water supplies, housing, income and sanitation were required to reverse the urban-rural gradient to the point where urban life expectancies exceeded rural (a point reached by the 1930s).

However, the example of smallpox illustrates the complex interplay of pathogen life histories, local policies, migration patterns and immunisation and other disease control strategies that continue to influence epidemiological interactions between rural and urban settlements. These interactions are historically contingent, a point that has given fresh force by recent reversals of urban-rural life expectancies in some affluent nations as a consequence of urban deprivation and changes in the main causes of death.

in patterns of circulation of smallpox in rural populations appears to have arisen from differences in local responses to smallpox.

In the south, smallpox victims were isolated, and markets closed to prevent outbreaks. In addition, once inoculation (a forerunner of vaccination, involving immunisation with a low dose of smallpox) became popular then many southern parishes performed occasional mass immunisations of the entire vulnerable population to prevent outbreaks. Northern communities did not adopt these tactics, possibly because they lacked the means to provide publicly-funded isolation facilities and free

mass inoculations. The circulation of smallpox as a childhood disease throughout northern Britain increased smallpox mortality in rural areas, but also reduced the mortality gradient between town and country, lessening the risks of rural-urban migration in the north compared with southern Britain.

After 1800, the enormous decline in smallpox infection with vaccination made cities substantially safer for young children and for especially southern migrants. Vaccination made a major contribution to reducing urban mortality rates and in reducing the human and demographic costs of the unprecedented urbanisation that



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# UK's productivity puzzle: What can we learn from the UK's mid-sized cities?

Cllr Imran Khan, Bradford Council and Portfolio Holder for Skills, Key Cities examines the UK's productivity puzzle, and asks what can we learn from the UK's mid-sized cities?

Productivity growth in the UK has remained largely stagnant for the past ten years and is now 26% behind the United States and 15% behind the G7 countries' average.

A recent OECD Report also placed the UK far behind our closest competitor nations in terms of the proportion of adults categorised as low performers in numeracy or literacy, ranking 18th out of the 29 OECD countries. While a variety of factors have contributed to lower productivity rates, the UK's skills gap stands out as a significant barrier to increasing productivity levels.

Automation and globalisation are transforming the demand for skills in the workplace. A recent report by Universities UK, "Solving future skills challenges" highlights this, stating that by 2030, it is estimated there will be a talent deficit of between 600,000 to 1.2 million workers across the UK's financial, business, technology, media and telecommunications sectors – a staggering figure which simply must not be ignored.

Skills shortages are restricting firms from expanding domestically and, in turn, denying job opportunities to local people. At a national level, these shortages are a serious impediment to economic growth and a strong national economy.

## **Key Cities: Important lessons from the UK's medium-sized cities**

During the summer of 2013, the Key Cities Group was formed, a cross-party initiative comprised of middle-tiered cities from all corners of the UK.

Our ambition is to build resilient and high-value city economies, and residents who are in employment and see a future in their cities. With a combined Gross



*Cllr Imran Khan, Bradford Council  
and Portfolio Holder for Skills*

Value Added (GVA) of £149 billion and population of over 7.2 million Britons, we collectively have a unique perspective on ways to meet these challenges right across the UK at a local level.

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*“Employing more than three million people across the UK, the business services sector plays a crucial role in ensuring Britain’s workforce is equipped with the relevant skills and training programmes to help develop careers and, ultimately, deliver economic growth that is truly inclusive and benefits local economies.”*

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To achieve our ambition, we must work in partnership – with government, employers and the range of local stakeholders. We are committed to joint working but also dedicated to providing local leadership.

As an example, Key Cities members Derby, Portsmouth and Southampton have all achieved productivity and

export levels that are ahead of the national average; while Bradford offers the highest productivity per worker (£49,000) of any city in the Northern Powerhouse.

Whilst the economic profile for each city differs within the group, the need for skills and human capital to meet the demands of businesses is a challenge that unites us all. Both now and in the future, domestic firms, potential investors and emerging technologies will continue to require access to the highest levels of talent to ensure that the UK remains a competitive location for business.

An important first step in addressing these challenges is the principle of devolution of freedoms, powers and resources for Key Cities to deliver real change and improvement. As a group, Key Cities has a wealth of experience and the ability to draw unique insights from a range of sectors and demographics to drive integration, increase performance, realise efficiencies and deliver services that meet the needs of local people and employers.

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**“Automation and globalisation are transforming the demand for skills in the workplace. A recent report by Universities UK, “Solving future skills challenges” highlights this, stating that by 2030, it is estimated there will be a talent deficit of between 600,000 to 1.2 million workers across the UK’s financial, business, technology, media and telecommunications sectors – a staggering figure which simply must not be ignored.”**

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It is also paramount to reap the rewards from Key Cities’ unique strengths – scale and greater agility, which enable the group to focus on very specific areas of competitive advantage and work with the government to provide the required levels of investment and lead local policy and interventions to address the skills gap and improve productivity growth.

### **Business services: a template for success**

Employing more than three million people across the UK, the business services sector plays a crucial role in ensuring Britain’s workforce is equipped with the relevant skills and training programmes to help develop careers and, ultimately, deliver economic growth that is truly inclusive and benefits local economies.

Earlier in 2018, Key Cities announced a partnership with the Business Services Association (BSA) to deliver a range of initiatives to promote future skills development.

As part of this, Key Cities and the BSA held three regional workshop sessions in Bradford, Coventry and Southampton with a particular focus on skills development. These sessions have been incredibly effective and illustrate just one way in which Key Cities is helping to shape a skills system that works for the local communities, cities and industry.

Digital technologies are also another area of focus for Key Cities. Bradford has a thriving and innovative digital sector with 700 companies employing 4,500 people, digital skills are one of three priorities for the Leeds City Region Employment, and Skills Plan, This sector offers significant untapped growth potential, which, if used effectively, can rapidly improve productivity levels and develop new partnerships between firms across different sectors and regions.

### **Ready to solve the productivity puzzle**

Working closely with stakeholders to develop local policy and practices that truly address the skills gap would not only make a huge difference to UK productivity but the overall economic health of the nation, too.

Key Cities are ready, willing and able to solve the UK’s productivity puzzle. We can only do this in partnership with government, employers and a range of local partners. However, these efforts will be more powerful and effective if Key Cities had the necessary devolved freedoms, powers, and resources to ensure that Britain’s cities are able to meet the skills requirements of its businesses. ■

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# Declining support for a generous asylum policy in Europe

Dr Gideon Bolt, Utrecht University, discusses the need to increase support for a generous asylum policy in Europe before the refugee crisis

In a previous contribution to this journal, I analysed the support for a generous asylum policy in European countries (Bolt, 2017). On average, 47.5% of the people in the countries that are included in the European Social Survey (ESS) agreed that governments should be generous when judging applications for refugee status, while 26.0% disagreed. These numbers are based on round seven of the ESS which took place in 2014, prior to the surge of refugees in 2015 and 2016 (Bansak et al., 2016). In this

analysis, I will evaluate how the opinions about asylum policy have changed between 2014 and 2016.

## Declining support

Out of the 18 countries in round 8 of the ESS survey (2016), there is in the Czech Republic least support for a generous judgement of asylum applications (table 1). Only 11.8% of the Czech population agrees with the statement while 69.4 disagrees. The difference in these two percentages is used to order the countries by

support for a generous judgement (ranging from least to most support).

Most support can be found in Ireland and Northern European countries (Iceland, Norway, Sweden). Three out of the top four countries with least support are Eastern European countries. Out of the Western European countries, there is least support for a generous judgement in the Netherlands (number three on the list).

The last column of table 1 shows the trend in support between 2014 (round 7 of ESS) and 2016. A positive figure indicates a trend towards more support, a negative figure a trend towards

Table 1: Support for statement that the government should be generous in judging people's applications for refugee status by ESS-country (Countries ranked from least support to most support)

	Agree 2016	Neither Agree nor Disagree 2016	Disagree 2016	Difference Agree/Disagree 2016	Trend 2014-2016
Czech Republic	11.8	18.8	69.4	-57.6	-34.0
Estonia	12.9	19.0	68.1	-55.2	-34.1
Netherlands	16.7	16.0	67.3	-50.6	-35.4
Russian Federation	15.7	31.7	52.6	-36.9	N.A
Israel	21.3	29.2	49.5	-28.2	-4.2
Austria	27.3	23.1	49.6	-22.3	-27.2
Germany	27.2	23.8	49.0	-21.8	-27.6
Belgium	30.5	19.5	50.0	-19.5	-5.2
Slovenia	27.2	28.9	43.8	-16.6	-32.2
Switzerland	36.4	28.7	35.0	1.4	0.9
Finland	38.1	32.1	29.8	8.3	-19.2
Poland	46.9	32.4	20.7	26.2	-28.5
France	54.3	18.8	27.0	27.3	-13.3
United Kingdom	50.9	25.8	23.3	27.6	8.1
Sweden	48.2	34.8	17.0	31.2	-17.9
Norway	55.5	24.5	20.0	35.5	-3.6
Ireland	60.3	18.8	20.8	39.5	3.6
Iceland	57.2	26.4	16.3	40.9	N.A

Sources: ESS Round 8 (2016). Data file edition 1.0. NSD - Norwegian Centre for Research Data, Norway - Data Archive and distributor of ESS data for ESS ERIC. ESS Round 7 (2014). Data file edition 2.1. NSD - Norwegian Centre for Research Data, Norway - Data Archive and distributor of ESS data for ESS ERIC.



Table 2: Percentage foreign born and asylum applicants by ESS-country

	Asylum applicants 2015+2016 per 1,000 inhabitants	% foreign born
Czech Republic	0.3	4.1
Estonia	0.3	14.7
Netherlands	3.9	12.1
Russian Federation	0.2	7.7
Israel	1.6	22.5
Austria	15.0	18.2
Germany	14.9	13.3
Belgium	5.6	16.3
Slovenia	0.8	11.7
Switzerland	8.0	27.9
Finland	6.9	6.0
Poland	0.6	1.6
France	2.4	11.8
United Kingdom	1.2	13.2
Sweden	19.4	17.0
Norway	6.6	14.8
Ireland	1.2	16.9
Iceland	4.4	12.6
Support 2016	+0.16	+0.06
Trend 2014-2016	-0.05	+0.53

less support. For two countries (Iceland and Russian Federation) there are no data available for 2014.

In three countries (United Kingdom, Ireland and Switzerland) there is a (minor) trend towards more support for a generous judgement of asylum applications, while 13 countries witness a negative trend. Support has shrunk most drastically in the Netherlands. Also, in Austria, Germany and the four post-socialist countries in the sample (Czech Republic, Estonia, Slovenia, Poland) there is a substantial drop in the support for a generous judgement.

## The link with the rise in asylum applications

The overall negative trend is undoubtedly related to the rise in the number of asylum applications in 2015 and 2016. That does not mean that the trend is most negative in countries that receive most asylum applicants.

The correlation between the trend variable and the relative number of asylum applicants (the number of applicants per 1000 inhabitants) is negligible (-0.05) and there is even a small positive correlation (+0.16) between support for generosity and the number of applicants (table 2). Czech Republic, Estonia, Russia and Israel combine a low support for a generous judgement of asylum applications with a very limited inflow of refugees.

Also, the Netherlands has a limited inflow compared to countries like Austria, Sweden and Germany. Although there is also a negative trend in the latter countries, there is substantially more support for a generous judgement of asylum applications than in the Netherlands.

There is hardly any association between the percentage of foreign-born and the generosity variable (table

2, column 2). A higher percentage of immigrants does not lead to a higher or lower support for generosity in the judgement of asylum applications.

At the same time, there is a strong positive association between the proportion of foreign-born residents in a country and the trend variable (+0.53). That means that the support for a generous judgement of asylum applications has dropped less dramatically in countries with a high percentage of immigrants. This may be in line with the contact hypothesis: people who live amongst members of minority ethnic groups are more likely to have a welcoming attitude towards out-group members. Further research is needed to dig deeper into the mechanism that may explain this statistical association (Bolt & Wetsteijn, 2018).

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# The role of modular in addressing the UK's housing crisis

astudio architects explain that modular has an important part to play in addressing the UK's housing crisis

**T**he UK's housing crisis demands urgent answers and decisive action. The gap between the number of houses currently being built and the number required is alarming and is exacerbating the unaffordable house price issue. Nationwide, house-building needs to almost double to hit the government's target of 300,000 new homes a year by the middle of the next decade.

It is not just a question of picking up the pace of construction, however quickly. The critical point is to deliver affordable housing. In 2017, 70,000 families were forced to live in emergency housing.

This will require political will and innovative thinking. In London, for example, the Office for National Statistics (ONS) estimates that 844,000 new homes will be needed by 2041 – but that fewer than 54,000 have been built in the previous two years. There is certainly a case to be made in favour of easing construction restrictions on parts of the green belt: not to damage the integrity of rightly cherished areas of natural beauty, but to consider developing portions of brownfield land which has an arbitrary 'green' designation.

This, however, will achieve little if most people continue to be priced out of the market. According to a recent report by the CBRE, barely a quarter of homes built or approved on greenfield land in the past decade are considered affordable under the government's definition.

There is no easy solution to the affordability problem. But there are compelling reasons to think that modular housing has a part to play.

The UK's housebuilding industry faces stifling cost pressures. Resources, skills, and materials are in short supply. Last year, for example, research by the Federation

of Master Builders found that some small building firms were being told to wait for more than a year for brick orders.

One advantage of modular houses is that they have the potential to save more than a third of the costs of construction. They can cost as little as £125,000 to build – compared to an average of £200,000 using traditional methods. Off-site production allows for materials and components to be purchased in bulk, and the manufacturing methods are far more efficient.

Prefabricated homes can be built in as little as three to four days – and the process is not easily disrupted, for example, by the whims of UK weather conditions.

Today's prefabricated homes are typically at the highest end of the energy efficiency scale. The use of a repeatable template in their manufacturing helps new forms of renewable energy and heat recovery systems to be widely adopted – and reduces the potential for defects in their replication. In other words, they have turned quality of construction and efficiency into their hallmarks.

What about their desirability? Architects have long held qualms that modular construction constrains design creativity. This may have been a defensible view in the past. But recent technological innovations, such as in 3D modelling, have unleashed a new wave of ingenuity. The result is that modular buildings, large and small, require every bit as much creativity and skill as their traditional counterparts.

We have supplied our own proprietary modular building method to Be First, the London Borough of Barking and Dagenham's regeneration company. As an example of modular, this is a volumetric manufacturing

## THE BUILT ENVIRONMENT



*East Wick & Sweetwater. Working on behalf of Places for People and Balfour Beatty, we have created over 100 apartments and townhouse units including mixed uses and community spaces at ground floor level creating inclusive affordable homes for London.*

method, which expedites the assembly of low-energy homes, fitted-out, completed and manufactured offsite using precision methods of engineering to provide robust, high-design, high-quality modular housing.

There is no questioning that investment in modular housing is growing. London's City Hall has indicated that it is willing to give more funding to modular development. Homes England has also provided financial support for the industry. Earlier this year, Sadiq Khan, the Mayor of London, awarded £11 million from the GLA Innovation Fund to a group of 16 London Boroughs that plan to deliver modular housing as emergency housing for homeless families.

Design challenges remain. If the sector is to reach its potential, modular manufacturers need to do more to foster greater standardisation of their respective building methods – to make modular housing a viable option on a large scale.

It's important to recognise, however, that in itself modular building is not a panacea. There is a broader framework to be fixed. Finding solutions to the UK's dearth of affordable housing will require developers and landowners to come together with local councils

and communities on a much grander scale. Land urgently needs to be freed up. Reducing the price of constructing homes will not tackle the roots of this crisis if we cannot find affordable land to build them on.

The £500 million increase in the UK's Housing Infrastructure Fund in the Chancellor's last Budget is an encouraging step. It is welcome that the funds are being focused on parts of the industry currently better able to build affordable homes, such as the housing associations. But a great deal more needs to be done if we are to make inroads into the estimated £68 billion that needs to be spent, to build 300,000 properties per year required to keep pace with demand. Modular building is a very good start. ■

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# Why is so much of England's housing stock empty at a time of national housing crisis?

Chris Bailey of Action on Empty Homes addresses the question of exactly why is so much of England's housing stock empty at a time of national housing crisis

There are lots of reasons why this is a unique point in British public policymaking but meanwhile on the home front, so as to speak, the social problems and inequality issues which arguably drove us to our current paroxysm of self-harm and Euro-vandalism rumble on.

Another unique aspect of the current situation in England in particular (and it is after all principally England's voting behaviour which has driven us to where we are in so many areas) is that for the first time in a generation we find that my own area of work, housing policy, is near the top of the public agenda whenever polling on issues of concern to voters is carried out.

This is not normal, despite the parlous state of some of the country's housing stock, both publicly and privately owned. Equally abnormal is to find every major party acknowledging that we are in the midst of a national housing crisis and seeking policy solutions to this.

## So where do almost a quarter of a million so-called long-term empty homes fit into this?

It is widely acknowledged that our housing crisis is one of supply, affordability and quality and empty homes are a canary in the coal mine for all three issues as new figures released by the government on November 14th, 2018, (the day that the draft Brexit deal was made public) illustrate<sup>1</sup>. Across the country, the rise in numbers is over 5%, with London seeing rises of over 14% in central areas where markets have been shaken by pre-Brexit jitters and 11% across the City-region. However, both low and high-value areas of the country's highly regionally diverse property market have seen rises.

By way of example, the central London Borough Camden has a rate of long-term vacancy of 1.39%

(considered to be within the highest band when we analyse the issue), while Kingston upon Hull is at a similar 1.36%. Both saw year on year rises at above the national average rate. Yet average Victorian (nineteenth century built) terraced homes in Camden that are structurally and stylistically identical to those in Hull, and in similar non-prime local situations, sell for at least 20 times the market price of those in Hull – £1.2 million plus as against £60,000 in central Hull.

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**“Empty homes are a symbol of a housing market out of control and a laissez-faire approach to social provision, which is storing up a timebomb of negative social outcomes and public dissatisfaction for the UK government. It would be wise if UK policymakers heeded the call of this canary in the coal mine of British public policy.”**

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Visit both areas and you'll see people sleeping on the streets. Visit the local authorities' housing offices and you'll see excellent work by local officers to incentivise property use for those in housing need; and long waiting lists for social (public) housing. It is widely acknowledged that Britain lacks housing full stop. It is estimated that we have a shortfall of between 1 and 4 million homes.<sup>2</sup>

In England, in particular, affordability is an issue, with London data alone showing that nearly a million people (962,000) renting their homes in the private rented sector live in poverty<sup>3</sup> (with high rents and lack of access to affordable or social housing options a significant contributory factor to this shocking number in what is still currently a global top ten economy).

## Why are homes left empty?

Homes are left empty for many reasons. At Action on Empty Homes, the charity which produces the only



authoritative and independent annual analysis of government data on empty homes in England, we divide empty homes into three categories:

**1. Clusters** – these are predominantly in low-value areas characterised by high levels of poverty and social disadvantage and dominated by low-quality provision of housing in the private rented sector, which is often supported by public welfare payments. Much of this is owned by so-called absentee landlords often resident in other higher value areas of the country, or in some cases overseas, many of whom operate a low investment model. This is facilitated by the relatively low level of regulation of the Private Rented Sector (PRS) in the UK and best exemplified by the fact that despite nearly half (40%) of the public social housing bill (welfare expenditure through support for rent) being spent in the private sector (over £9 billion of £23 billion). The Decent Homes Standard (a minimum quality housing provision regulation) applied to that expenditure when purchased from the social and public housing sectors does not apply in the PRS.

Other significant factors include low insulation standards in pre-1919 constructed terraced homes. The low

investment model dominant in such areas means that these are frequently expensive to heat for poor tenants; unless exterior insulation is added. Thus, where this has not occurred vacancy rates may increase as these become homes of last resort to be vacated as soon as tenants can access alternative accommodation.

**2. Pockets**, these are local concentrations within areas which would not otherwise be considered disadvantaged but which are nonetheless likely to feature at a very local level some of the same characteristics as those present on a larger scale in clusters; they are in a sense ‘bad streets’ or ‘poor blocks’, where local disadvantage is concentrated within what might otherwise appear affluent or averagely well-off areas. They reflect on a more local scale some of the ‘social sorting’ and residualisation seen in larger clusters in areas of deprivation. Again, ownership is often by landlords resident outside the local area and operating a low investment model with tenants supported by welfare payments.

**3. Bad teeth**, these are single and isolated examples of empty property on otherwise ‘normal’ streets and exist across a wide range of values and in almost all



areas. Often empty as a result of complications related to personal circumstances, contested or confused inheritance or complex personal circumstances, such as physical or mental illness; equally they may on some occasions result from disengaged overseas resident owners or properties purchased as investments in the hope of value uplift. Money laundering from the proceeds of crime is speculated to play a role in some cases. Other factors include the cost of renovation of outdated property inherited by relatives who lack the finance, knowledge or in some cases, simply the time and enthusiasm to take on the project.

### **There are broadly three strong arguments for investment to reverse the growing numbers of empty homes of all types**

Firstly, there are simply too many and any readily accessible supply of essentially habitable homes which could be brought into use quickly should be accessed in a widely acknowledged national housing crisis, with nearly 80,000<sup>4</sup> families currently in state-financed and frequently unsuitable temporary accommodation (at an annual public cost of around £1 billion a year).

The last significant government programme to do this through a mix of grants, loans and other incentives to local authorities and charitable and social enterprise housing providers ended in 2015 and numbers of empty homes have risen since, with the rate of rise doubling in the last year to 5%. That programme renovated almost 10,000 homes at a cost of around £200 million – an average cost of around £24,000 per home, which is less than half the cost of commissioning new homes.

In another Northern European country facing a housing crisis, the Republic of Ireland, with whom the UK

famously shares its only European land border, the government recently announced a new national empty homes programme as Pillar 5 of its [‘Rebuilding Ireland 2018-21’ strategy](#) following initial commitments made in August 2017. This creates a statutory role for local authorities in action to bring an empty property into use and a funding stream to achieve this.

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**“In England, in particular, affordability is an issue, with London data alone showing that nearly a million people (962,000) renting their homes in the private rented sector live in poverty (with high rents and lack of access to affordable or social housing options a significant contributory factor to this shocking number in what is still currently a global top ten economy).”**

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Secondly, empty homes blight communities, damaging the quality of life for neighbours as magnets for crime, decay and pest infestation and where concentrated in pockets or clusters can create a downward spiral of undesirability leading to a flight by owner-occupiers, dominance by the low investment end of the private rented sector and a concentration of social problems.

Thirdly, we know how to do this and it would save the public money, as well as improving the lives of those housed. But at present in the UK (unlike Ireland), this is not a statutory function of local authorities. Furthermore, the UK is still in an era of public austerity driven by political choices on behalf of the UK government and cuts to central expenditure allocations to local government, alongside minimal freedom to exercise local tax-raising powers. As a result, work is patchy and under-resourced with many local authority areas employing no dedicated staff to take either enforcement





Chris Bailey

Empty homes are a symbol of a housing market out of control and a laissez-faire approach to social provision, which is storing up a timebomb of negative social outcomes and public dissatisfaction for the UK government. It would be wise if UK policymakers heeded the call of this canary in the coal mine of British public policy. ■

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- 5 House of Commons Library 'Households in temporary accommodation (England)' (26 July 2018) <https://researchbriefings.parliament.uk/ResearchBriefing/Summary/SN02110/>

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action or to support incentives and investment-based approaches. Although those that do so find success and public benefit from it. Furthermore, the public wants action, public polling for Action on Empty Homes by ComRes shows that 83% of British adults said the government should place a higher priority on tackling empty homes.

Empty Homes are a symbol of Britain's broken social contract where the right to housing is no longer the right to a decent home, a permanent home or an affordable home for millions of citizens. Nor a right to housing where citizens want to live. We see the impact of this from Brexit votes in the under-invested or 'left behind' communities of the North to anger at Buy to Leave in London, where planning permission has been granted for a stunning 510 tall residential towers, even as those recently constructed see homes being stock-piled by developers unwilling to sell at prices dented by pre-Brexit jitters; and while London local councils place 54,550<sup>5</sup> families including over 80,000 children in often unsuitable and over-crowded temporary accommodation at great cost to taxpayers.

This is public expenditure on housing some of the most vulnerable in society in some of the worst housing in the UK and could better be invested in renovating existing homes and bringing back into use long-term empty dwellings.

# Vacant property management: Aspiring to the highest standards

Stuart Woolgar, Chief Executive of Global Guardians Management, is an outspoken campaigner to bring tighter regulation and higher ethical standards to the vacant property management sector. Here, he details why we should all aspire to operate at the highest standards in our business activities

Compliance to standards, regulations and ethical practices is critical as a demonstration to its public that an organisation is conducting itself correctly. These standards and regulations, particularly where they relate to health and safety, have and will continue to impact on and even save people's lives and should never be dismissed as petty or irrelevant.

For agencies or businesses who contract to work for organisations in the public sector, where those organisations are open to full public scrutiny and accountability, clarity and transparency in their activities will, therefore, also need to be demonstrated.

Where there is no specific law to comply with, the next best thing is regulation, or compliance to standards of good practice, usually drawn up by the British Standards Institute (BSI) with the input of industry experts, government bodies and accredited professional or trade associations.

Regulatory compliance is particularly strict in the financial sector these days, following the financial crash a decade ago. Lessons were learned and regulations and standards have since been reviewed and considerably tightened, so are now far stricter in the endeavour to avoid a repeat of the meltdown that occurred.



## Standards in the built environment

However, it is essential that standards in the built environment should also be rigorously monitored and kept up to date, especially where health and safety are concerned; those operating in the property sector need to adhere to a whole raft of both legislation and regulation, plus follow standards laid out in various codes of practice. What happened at Grenfell is an unfortunate lesson to learn from. Standards were out of date, in particular where they related to the cladding, and it should not take a further similar tragedy to bring them into line with modern building technology.

It follows, therefore, that vigilant and energetic, accredited professional bodies or trade associations, along with industry experts and thought leaders, should all play their part in

ensuring members not only comply with regulations and standards but also contribute to up to date and forward-thinking where those standards are concerned. Health and safety is the responsibility of everyone and it shouldn't be financial considerations, carelessness or the threat of litigation that ensures the highest standards are aspired to when people's lives and wellbeing are concerned.

## The problems that come with vacant property

Vacant property can be a minefield and headache to manage, but it can also be an opportunity for social good when homelessness is a national scandal and lack of affordable and easily available accommodation is in such short supply.

Empty buildings can be a magnet for a host of problems and unexpected costs. If a building looks empty, neglected or run-down, it's an open invitation to trouble – from squatters, fly-tippers, criminals, drug dealers, even homeless people simply looking for somewhere more sheltered to spend their nights, especially during the winter months. The option of secure fencing, shutters or boarding around a site merely attracts disfiguring graffiti and doesn't keep out anti-social or criminal behaviour; nor do CCTV or alarms; the perpetrators

are usually long gone before security patrols or the police arrive. Determined thieves will target anything with a scrap value and this can cause immense damage to a property and make it potentially dangerous and unsafe to enter. Security guards and dogs generally can't be there 24/7, the budget for that is simply impractical in the long-term unless the building is of special importance.

In tandem with all of this are the costs of business rates and insurance cover. Although some public and local authority properties are exempt from rates, and some government buildings are self-insured, not all are, so there are still costs to be borne even if a building is vacant. It is also worth remembering, that if any third party visits or trespasses into a vacant building and suffers a mishap, the property owner is still liable and 'no win no fee' lawyers abound, encouraging people to seek damages.

A simple solution to all the above problems associated with vacant buildings is to install property guardians in the premises through an ethical and responsible company that can turn the void into an income generator, as opposed to a drain, for as long as is necessary. They live on the site and are present 24/7, 365 days of the year.

In one fell swoop, the building becomes secured, the guardian company maintains it and ensures there are adequate living and domestic facilities there for its guardians, business rates liability is mitigated, insurance cover can benefit, income can be generated to offset any other financial charges and, importantly, an otherwise vacant building gets turned into a low-cost accommodation opportunity so the social benefit is enormous.

## Compliance to health and safety standards and industry codes of practice

One point is absolutely critical when installing property guardians to secure a vacant building. For all the reasons listed at the beginning of this article, and more, an accredited guardian company, such as Global Guardians, must be used. In other words, a company which belongs to the British Security Industry Association, (BSIA) and also complies to British Standard 8584:2015 (Vacant Property Protection Services – Code of Practice) which is backed by the BSIA, Environmental Health, London Fire Brigade and many other public service bodies.

By complying to BS8584, the guardians will not only be treated responsibly and ethically, but the property owners can be reassured the guardian company is complying with every relevant aspect of current housing and property legislation and regulation, as well as all health and safety regulations. Regrettably, not all guardian companies do this which puts guardians at risk and leaves property owners liable for various problems which may occur.

If utilising the services of an accredited guardian company, their maintenance team and/or specialist contractors should carry out all works necessary to bring the property to proper occupational standards and ensure all other national and local regulations are complied with as necessary, for example, the Housing Health and Safety Rating System (HHSRS), the Occupiers Liability Act 1957 and HMO legislation.

To do this in the first instance, the guardian company should institute a site visit by accredited professionals to carry out a full risk assessment, including inspection of all security, fire, and health and safety implications. This

needs to be done to comply with employers' liability and work in tandem with property owners' liability and the Fire Safety Order 2005. This ensures the five key areas are covered: fire, water, gas, electrical and asbestos safety. This is part of the work that the guardian company does before installing guardians into the property and they bear the cost of this, not the property owners.

Global Guardians are renowned for our pioneering work to bring better standards to the industry and our campaign to be the gold standard for property guardianship through the work we do with the BSIA, the development of the BS8584, together with a new industry standard code of practice which is currently being drafted. We are also campaigning with the GLA for better regulation of the property guardian market in London.

Regrettably, there will always be mavericks in any industry who ignore regulations and bring it into disrepute, but we are fighting back and any organisation, either public or private, who wishes to demonstrate best practice in their work, now seek us out in the knowledge that we strive for excellence, and compliance in all areas is our mantra.



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# Ocean energy: Time to unleash the current

**Gesine Meissner MEP, Special Envoy to the President of the European Parliament on Maritime Policy, shares her thoughts on ocean energy and why now is the time to unleash the current so that renewable technologies in Europe are pushed forward**

Unlike wind and solar power, ocean energy is reliable and predictable. Waves are available all year round, the tides are fixed and the salt content of the sea is almost constant. The amount of CO<sub>2</sub> released during production is low and the associated electricity costs are as well. Studies show that so-called Blue Energy has the potential of meeting 10% of the EU's power demand by 2050. This would cover the daily electricity needs of 76 million households. Almost all major technology developers have their headquarters in Europe. The sector should be worth €53 billion annually in 2050. So, what is holding back this energy source from flourishing?

While European companies are a clear frontrunner in this technology and account for a large share of patents

globally, it remains a comparably expensive technology. Most ocean energy projects are still in their test phase and initial funding is difficult to obtain. Beyond this obstacle, there is also a lack of appropriate infrastructure. In fact, transmission networks to distribute the energy produced have not been sufficiently expanded yet. Furthermore, the impact of certain projects on the surrounding ecosystems (animals, algae and coastal structures etc.) are still partly unknown and are becoming an increasing point of concern when planning. There is a similar concern regarding the overall lifecycle carbon cost of this energy.

I would, however, argue that the real obstacle to success is its lack of visibility at the political level. And this, despite Europe being a leader in this field. But

Image: © Hagen Wolf



**Gesine Meissner MEP**

while scientists and policy experts have recognised the potential of ocean energy a long time ago, it is still not acknowledged by the mainstream policymakers.

As witnessed with the development of other renewable technologies in Europe, initial public investment is key to attract and accelerate private investment. While the projects that currently exist are mainly local or national ones, developing a real European interest could provide the push needed for the sustainable commercialisation of ocean energy. Many European countries have ocean access and as such, they have a shared interest in pushing for the development of this type of energy.

At the European level, things have already been moving in the right direction. Since 2014, the Commission has invested €150 million in ocean energy through its research and innovation framework programme, Horizon 2020. But we need further investment in researching, developing and testing blue energy. This is why I am

actively pushing for ocean research to remain a central element in the new research programme, Horizon Europe. The legislative package 'Clean Energy Package for all Europeans', sets a renewable energy target for the EU by 2030 of 32%. This is also a chance for ocean energy to contribute to achieving our climate goals, especially as ocean energy can work as a grid stabiliser in combination with other renewable kinds of energy.

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**“Almost all major technology developers have their headquarters in Europe. The sector should be worth €53 billion annually in 2050. So, what is holding back this energy source from flourishing?”**

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Moreover, we need to ensure that our oceans are not further damaged by marine pollution. While waves and tides are more reliable than other renewable energy sources, the ocean is also impacted by climate change. A recent study by the Geomar Helmholtz Center for Ocean Research shows that the warmer the ocean, the weaker the ocean circulation. This is another area where the European policymakers can play a key role.

Once the right political framework is in place, Blue Energy can become a profitable and sustainable economic sector. But this also requires a stronger involvement of the private sector, as well as the willingness of private investors to take risks. It is our job, as European leaders, to create the confidence needed for such investment. ■

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# Transforming the energy system: Going from black to green

Director General of the Danish Energy Agency, Kristoffer Böttzauw introduces the work in the Danish Energy Agency to transform the country's energy system and not least their efforts on the green transition globally

**W**ith the 2015 Paris Agreement, the world is on a new trajectory towards sustainable development and a low-carbon economy. Delivering on the promise of Paris requires countries to scale up renewable energy urgently and to use energy more efficiently.

For more than 30 years, the Danish Energy Agency has worked for a green transformation of the energy system in Denmark, and the results are promising:

- Today, Gross Energy Consumption is lower than in 1990 in spite of considerable economic growth;
- Renewable energy covers more than 30% of energy consumption and about 55% of electricity consumption;
- Danish emissions of greenhouse gases have been reduced by around 30% since 1990;
- We have experienced strong growth in Danish exports of energy technologies, and today the export accounts for 11% of the total Danish exports of commodities. This is the highest share in Europe.

The energy transition has been supported by a large majority of the Danish Parliament, which has ensured a stable framework for energy sector stakeholders and has minimised the risk associated to making the investments necessary for transforming the energy system. In June 2018, the government and all political parties in the Parliament agreed to a new Energy Agreement.

According to the agreement, three large offshore wind farms with a total capacity of 2,400 MW will be estab-



*Kristoffer Böttzauw  
Director General*

lished, significantly expanding the already high wind power production in Denmark. The new wind farms will contribute to Denmark already in 2030 being able to cover 100% of its electricity consumption with power from renewable energy sources.

By going from black to green, we are now on target to become independent of fossil fuels by 2050. Coal for power production will be phased out by 2030. That is an important milestone in our trajectory towards 2050. For the Danish Energy Agency, it is an important objective that the transition is carried out in a cost-effective manner and with minimum costs for the taxpayers and energy consumers.

## **High degree of security of supply**

The fluctuating nature of wind power and solar PV is a common challenge for all countries replacing fossil fuels with these technologies. Accordingly, new solutions ensuring a high degree of security of supply need to be developed and maintained. But our experiences



are good: 30 years ago we thought that the maximum share of wind power we could handle in the electricity supply would be 20%. Today, wind power covers 43% of electricity consumption, and the Danes still have power 99.996% of the time. That is the second highest degree of security of electricity supply in Europe.

Thanks to an efficient market setup within the Nordic countries and a good coupling to the German market, Denmark has avoided the curtailment of wind power. Furthermore, the power market has given strong incentives for the coal-fired power plants in Denmark to operate very flexible, typically down to 10% of their nameplate capacity.

The potential for wind power deployment in the North Sea remains huge: calculations show that it may cover up to 12% of electricity consumption in Europe corresponding to the consumption of 100 million households. But if costs should be kept at a reasonable level, countries around the North Sea need to coordinate the relevant regulation across the countries.

Just to mention a few examples, today, there are different requirements for the colour of the wind turbine foundations, and different regulations when it comes to workers' safety and the environment. This implies that staff on the service ships sometimes are required to change their safety shoes when crossing a national border. We are constantly working to strengthen the North Sea Energy Cooperation to avoid such unnecessary barriers, and if we succeed, the North Sea may develop into a Silicon Valley for wind power.

## **In-depth analysis and scenario projections are essential**

Long-term development of the energy system has so far been supported by in-depth analysis as well as baseline scenario projections. This has given Danish politicians confidence that the direction they wanted to steer the energy system towards, was realistic.

Overall, I would argue that our long tradition when it comes to energy system modelling and a holistic approach for energy planning has given Denmark valuable competencies. We believe that Danish experiences can provide important insights into how

nations can set out an ambitious and cost-effective path for a sustainable transformation of their energy systems.

## **Danish experience on the green transition can be used globally**

Since 2012, we have gradually expanded our cooperation with partner countries and offered Danish experiences and expertise in technologies and issues, such as onshore and offshore wind, power grid issues, district heating, energy efficiency, scenario-based policymaking, levelised cost of energy calculations and power system flexibility. Today, we partner with 14 countries that together cover more than 60% of the world's GHG emissions.

The most extensive co-operation programme is with China, where there is an ongoing collaboration between Chinese authorities and the Danish Energy Agency covering among other things, modelling and scenario-based policy with China National Renewable Energy Centre and a programme focused on improving the flexibility of Chinese thermal power plants. This broad cooperation aims at enabling China to achieve its climate and energy goals in a cost-efficient manner, taking advantage of the lessons learned in Denmark.

We hope that, by doing so, even though we are a small country, we are able to support the transition towards a greener, more sustainable, global economy. ■

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# Turning buildings into power stations: The UK's first energy-positive office

Developing low carbon, affordable buildings is a key challenge for the construction industry. What if technology could be harnessed to create power-generating, “energy-positive” structures? Dr Justin Searle, Technology Director of the SPECIFIC Innovation & Knowledge Centre at Swansea University, discusses a project that is doing just that

**B**uildings currently account for around 40% of UK energy consumption. However, a new office, just opened in Swansea, points the way to a very different future.

Why not design buildings to be power stations that can generate, store and release their own energy?

If it sounds like science fiction, come down to Swansea, where we've just opened a building that shows it can work. We call it the Active Office. It is the UK's first energy-positive office, capable of generating more solar energy than it consumes over the annual cycle.

The Active Office was designed by SPECIFIC, a national Innovation & Knowledge Centre led by Swansea University, with their key industrial partners, Tata Steel, NSG Group and AkzoNobel. SPECIFIC is leading change in construction, helping industry partners take new products to market by integrating them into new systems and demonstrating that they work.

We built the Active Office on Swansea University's Bay Campus, with construction – from concept to completion – taking us just eight months. Much of the work was carried out elsewhere and then assembled on site.

The individual technologies we used in the Active Office are impressive, from an integrated solar roof to battery storage.

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**“Significant too is the fact that all the technologies used are already commercially available, using existing supply chains. There is no reason why these could not be used on any new building.”**

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But what’s most significant is the fact that they all work together in one integrated system, generating, storing and releasing solar energy for heat and electricity.

The office has smart systems, including wireless access points and data infrastructure to support predictive operation, Internet of Things devices and smart building sensors. Extensive energy monitoring identifies sources and sinks of both electrical and thermal energy, providing information on how the energy is being distributed within the building.

Significant too is the fact that all the technologies used are already commercially available, using existing supply chains. There is no reason why these could not be used on any new building.

The Active Office is also demonstrating how an energy-resilient community could work. It has been designed to share energy with another building next door, the Active Classroom, which was the UK’s first energy-positive classroom.

The Classroom, recently named Project of the Year by RICS Wales, has shown that the “buildings as power stations” concept works. In its first year of operation, it generated more than one-and-a-half times the solar energy it consumed.

Now that the Office is up and running, the two Active Buildings will be able to share energy with each other, and with electric vehicles via three charging points. So what we have here are not just individual buildings, but a demonstration of an energy-resilient solar-powered community.

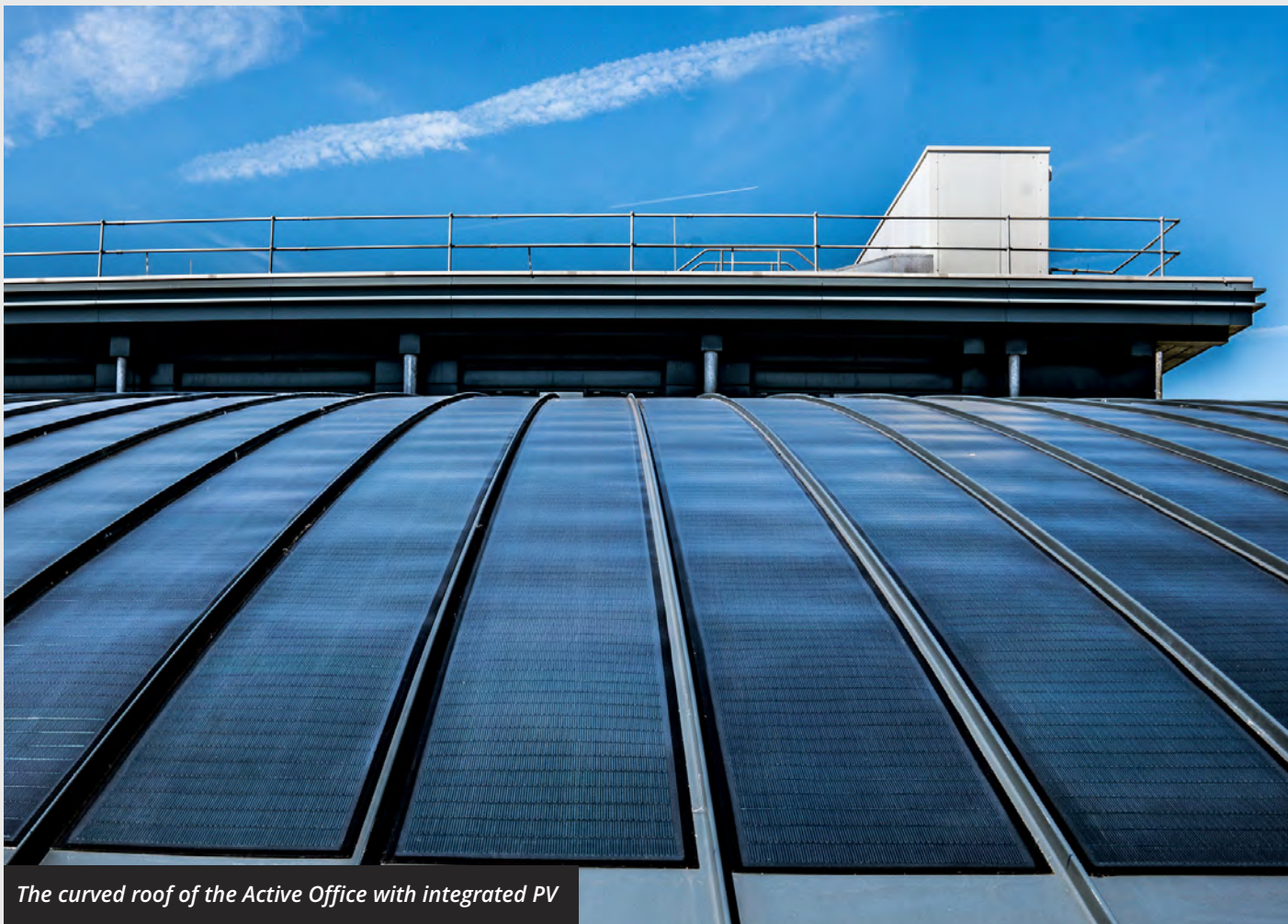
Let’s look at the individual technologies in use on the Active Office:

- The first curved integrated PV roof by BIPVco, which demonstrates the flexible nature of the 23kWp photovoltaic panels.
- 110kWh lithium ion phosphate batteries.
- First commercial installation of a wall-mounted photovoltaic thermal (PVT) system – capable of generating both heat and electricity – by Naked Energy.
- 2,000-litre water-based solar heat store capable of storing sufficient energy to provide space heating for the following day, (enabling time-shifting of electrical heating demand).
- Heating derived from solar energy by a combination of solar thermal, air source heat pump and an immersion heater. There is no gas supply in the building. A smart controller will use occupancy and weather forecasting information to optimise charging of the 2,000-litre cylinder.
- Three electric vehicle charging points.
- Steel cladding – Colorcoat Urban® on the external walls and roof and Coretinium internal wall cladding from Tata Steel.

As this list shows, while SPECIFIC has led the project, the Active Office has been a team effort from start to finish. The highly accelerated design and development timeline required extensive collaboration throughout the supply chain to ensure that deadlines were met, without sacrificing innovation or the aspiration of being energy positive.

Partners in the project include Wernick, for offsite building manufacture and construction management; Tata Steel, whose products include the Colorcoat Urban® cladding and roof panels; and Cisco Systems, who have developed the networking infrastructure and electric vehicle management systems.





*The curved roof of the Active Office with integrated PV*

Smaller collaborators include BIPVco, developer of the integrated solar roof; Naked Energy, whose photo-voltaic-thermal devices are capable of generating electricity and heat at the same time; and Dulas, who supplied the battery system.

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**“Why not design buildings to be power stations that can generate, store and release their own energy?”**

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The Active Office was funded by Innovate UK with support from Swansea University and the European Regional Development Fund through the Welsh Government. SPECIFIC also receives funding from the Engineering & Physical Sciences Research Council.

Now that the Office is open and in use, we will be gathering data to see how it works. As with the Active Classroom, this will help us refine the design.

Developing low-carbon affordable buildings is one of the biggest challenges for the construction industry of

the 21st century. With the Active Office and Classroom, we are showing how buildings can be power stations, helping us meet that challenge.

Come and see. Swansea just may be where the future is happening first. ■

**Dr Justin Searle**  
**Technology Director**

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# FROM VISION TO REALITY

Copenhagen International School (CIS) in Nordhavn, Copenhagen has the largest building integrated PV installation in Europe. It was delivered by Solar Lab and covers all facades and supplies 50% of its yearly electricity use with solar energy, and was a request from a dedicated builder (ECIS) to C.F Møller Architects.

Cenergia, which is now part of Kuben Management, has made Active House labelling, and an online [Active House radar](#). Based on this, an application for the Active House 2018 Award secured CIS as the overall winner and labelling category winner (see [www.activehouse.info](http://www.activehouse.info))

[www.activehousebipv.com](http://www.activehousebipv.com) | [www.activehouserooofsandfacades.com](http://www.activehouserooofsandfacades.com)

**KUBEN** NRG  
MANAGEMENT

# Nuclear fusion entering 2.0 Era: From fundamental research to technology development

Matteo Barbarino, Sehila M. Gonzalez de Vicente and Danas Ridikas from the International Atomic Energy Agency (IAEA) comment on nuclear fusion R&D

Taking advantage of Aston's experiments and Einstein's theory ( $E=mc^2$ ), Eddington first recognised the potential of nuclear fusion as an energy source. In his Presidential Address to the British Association at Cardiff in 1920<sup>1</sup>, he inferred: "A star is drawing on some vast reservoir of energy by means unknown to us. We sometimes dream that man will one day learn how to release it and use it for his service. The store is well-nigh inexhaustible, if only it could be tapped."

The race for fusion power had begun. By the mid-1930s, fusion was demonstrated in the lab<sup>2</sup>, and by the mid-1950s experimental fusion reactors were operating in the former Soviet Union, the U.S., Europe, and Japan.

In 1958, at the Second United Nations Conference on the Peaceful Uses of Atomic Energy, the results of controlled nuclear fusion research were first disclosed to the world at large<sup>3</sup>, and fusion energy became the dream of a virtually inexhaustible, safe, environmentally-friendly and universally-available energy source, capable of meeting global energy demands. But soon, it became evident that a better understanding of fundamental phenomena was needed before the goal of energy extraction from nuclear fusion could be reached; and the fact that such research is very complex and costly, enhanced the need for international cooperation, exchange of information and experience among all stakeholders engaged in this field of nuclear science and technology.

In this spirit, a combination of significant technical progress and successful international collaboration in magnetic fusion research resulted, in 1988, in commitments to cooperate, under the auspices of the Inter-

national Atomic Energy Agency (IAEA), in the conceptual design and supporting R&D for an International Thermonuclear Experimental Reactor (ITER).

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**"With the progress and experience of ITER under construction, attention is being paid to important areas, such as nuclear engineering, safety and radiological protection, as well as security, and the IAEA is taking steps to support these efforts."**

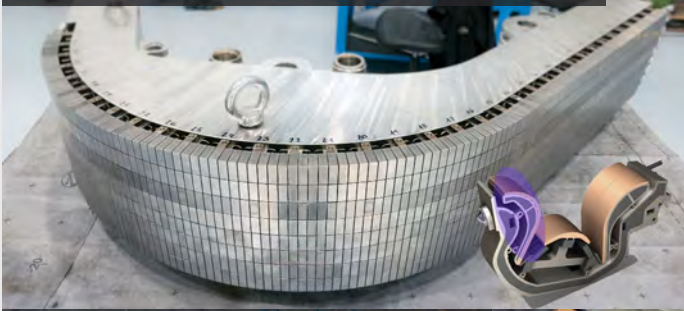
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During the last 30 years, international R&D activities in the field of fusion have made tremendous progress and have led to a new stage, characterised by the transition from studying high temperature plasma physics in fusion devices, which provides plasma parameters below breakeven condition (i.e.  $Q<1$ , where  $Q$  is the ratio between the fusion power and the power injected in the plasma to drive the burn) and rather limited neutron production, to the design and manufacturing of technologies, (such as superconducting magnets, vacuum vessel and in-vessel components, cryostats, heating and diagnostics, and remote handling and maintenance systems) essential for a fusion reactor like ITER<sup>4</sup>, intended for steady-state operation (i.e.  $Q>5$ ) and capable of generating sufficient neutron fluxes comparable or even more intense than in existing nuclear power plants.

Today, both governmental and private organisations<sup>5</sup> are actively involved in the process of prototyping and eventual commercialisation of nuclear fusion energy. R&D priorities are moving towards nuclear technology for fusion energy and industrial applications, including components design, manufacturing and testing, as well as diverse neutron applications<sup>6</sup>. One of the clear measures



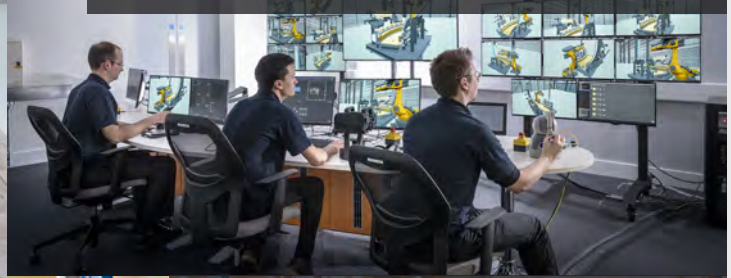
*The first prototype of the inner vertical target of the ITER divertor was produced in Europe on May 2018*



*The first ITER toroidal field coil winding pack was cold tested at 80K on May 2018*



*UKAEA's centre for Remote Applications in Challenging Environments (RACE) is designing and planning mockup trials for ITER's remote handling systems*



*The first segment of the ITER vacuum vessel was completed in South Korea on December 2017*



*Some of the ITER technologies completed or under development (e.g. magnets, vacuum vessel, divertor, remote handling systems)*

of this transition is the substantial growth (+700%) of research papers presented at the Fusion Energy Conference in the field of fusion technology since the beginning of the ITER Conceptual Design Activities in 1988, which is only partially a reflection of the increasing (+300%) overall number of papers presented at the conference during the last three decades<sup>7</sup>.

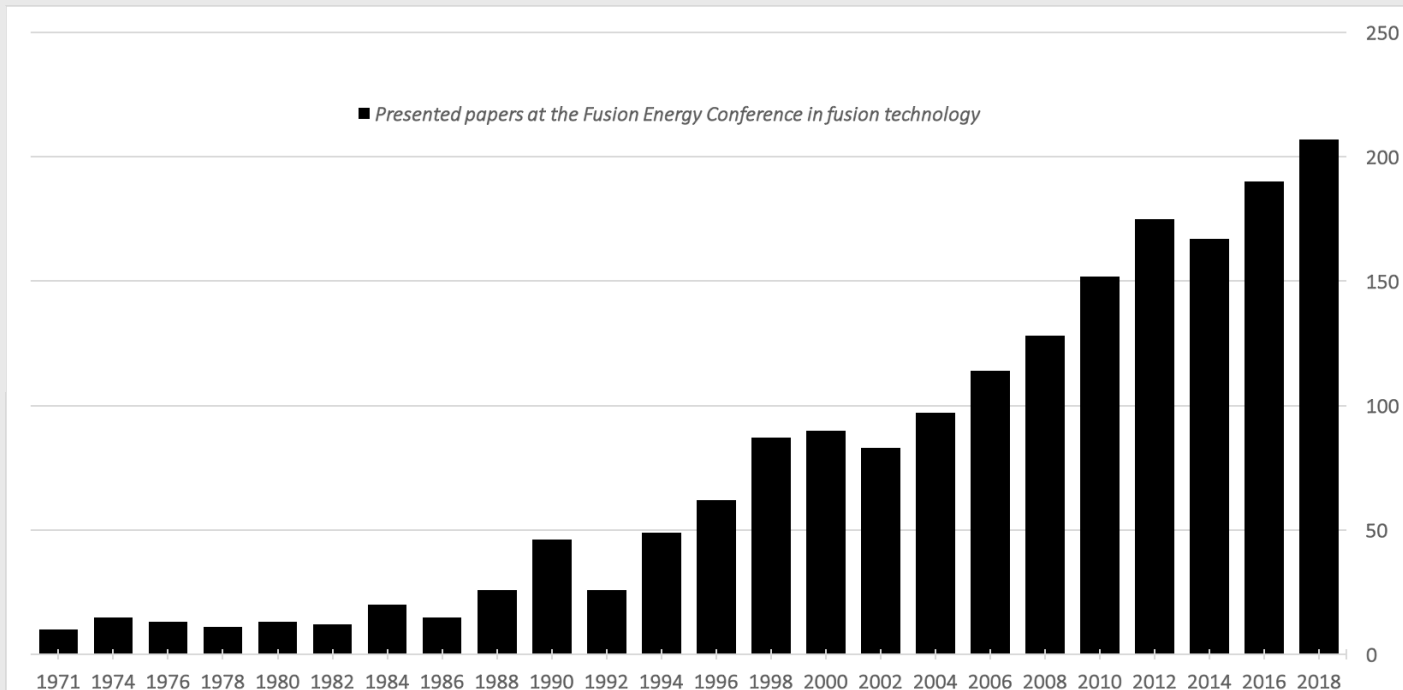
ITER and the next step fusion devices (e.g. JT-60SA under construction in Japan, CFETR in China and K-DEMO in South Korea in the design stages) present significant advances, which are seeing nuclear fusion entering the 2.0 Era, that will provide the databases in science and technology necessary for the design and construction of a demonstration fusion power plant (DEMO).

Meanwhile, individual countries are already exploring designs for such a DEMO reactor<sup>8</sup> that would build on the experience from ITER, and from the other ongoing international collaborations or domestic baseline programmes, to show that controlled nuclear fusion can generate net electrical power, tritium fuel self-sufficiency, reliable, safe and secure operating regimes, and mark the final step before the construction of a commercial fusion power plant.

The IAEA has played a key role for ITER's creation and its endeavours, and continues to cooperate with the ITER Organization based on the IAEA-ITER Cooperation Agreement, playing an important bridging function between the 35 ITER members and the other IAEA Member States through its periodic series of fusion energy conferences, workshops and technical meetings, coordinated research projects, and publishing the leading scientific journal in the field, Nuclear Fusion. The IAEA also acts as a central hub among its Member States developing programme plans and initiating new R&D activities leading to various concepts of a DEMO through the (DEMO) Programme Workshop<sup>8</sup>.

With the progress and experience of ITER under construction, attention is being paid to important areas, such as nuclear engineering, safety and radiological protection, as well as security, and the IAEA is taking steps to support these efforts<sup>9</sup>.

Big strides in understanding fusion energy science have been made. But more efforts with increased global collaboration and coordinated research are required to make nuclear fusion energy production a reality. The IAEA continues to be at the forefront of



*Presented papers at the Fusion Energy Conference in the field of fusion technology*



*Artwork of a DEMO*

these international efforts, and there is sufficient evidence to expect further developments of domestic and international activities in the nuclear fusion field in the coming years. ■

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# The European Commission's view on the fight against climate change

Maroš Šefčovič, Vice-President, Energy Union at European Commission speaks to Open Access Government about making cities smarter, and offers his opinions on European mobility and the Platform for Coal Regions in Transition, in the fight against climate change

In the [October 2018 edition](#) of Open Access Government, Maroš Šefčovič, Vice-President, Energy Union at European Commission spoke to us about establishing a European Energy Union and the importance of all Europeans having access to secure, affordable and climate-friendly energy.

In a previously unpublished part of the interview, Maroš Šefčovič offered some additional thoughts around government policy which are relevant to this publication. He notes that the European Commission is very much encouraged by the cooperation of the Mayors in Europe who are supporting the Global Covenant of Mayors, which Maroš Šefčovič is the Co-Chair of.

By way of background, he was present on 22nd March 2018 to celebrate the establishment of Global Covenant of Mayors for Climate & Energy's Global Secretariat in

Brussels, supporting cities around the globe in the fight against climate change. On this day, Šefčovič noted that The Global Covenant will be welcomed in Brussels, as Europe's Member States and cities have placed the fight against climate change at the heart of their priorities.<sup>(1)</sup>

Šefčovič explains to Open Access Government that mayors from all over the world are part of the Global Covenant of Mayors and that the Covenant of Mayors in the EU has 6,000 members. He then explains in his own words what they are aiming to achieve in terms of making cities smarter and "Urbis", developed by the Commission and the European Investment Bank in 2017 to help cities plan and implement their investment strategies.<sup>(2)</sup>

"Together, they are working on how to make cities smarter, cleaner and better for their citizens. Now, a platform has been established for cities and for Global



Image: © European Union 2018

Urbis: “Urbis” is a word which we created based on the word “urban”. So, on this platform, every mayor will have access to potential financing, with help from the European Investment Bank (EIB) and from the World Bank Group, which might be useful for smarter technologies.”<sup>(3)</sup>

In closing, Šefčovič also offers his opinions on European mobility and the Platform for Coal Regions in Transition, which both fit in with the EU’s commitment to a clean energy transition, something they believe is irreversible and non-negotiable.

“Also, what is very important for European Mobility is to make sure that our cities have less air pollution and, therefore, we propose that each city should be low or zero emission. This means the uptake of electric vehicles, hydrogen or hybrid engines which is quite a challenge. We have established the EU Battery Alliance<sup>(4)</sup> and they want to ensure that batteries are of the highest quality and manufactured in Europe, fully corresponding to the new electricity market and all the new energy legislation.

“Finally, we know it is important not to leave anyone behind and I know that in Europe and across the world,

the coal miners are worried about the future for their region and their jobs. Therefore, we started the Platform for Coal Regions in Transition where we are helping businesses to find a new economic future. So, the new investors could help a number of regions.”<sup>(5)</sup> ■

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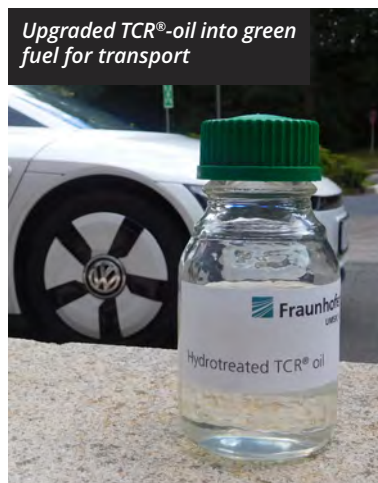
# Synthetic fuels and green hydrogen from organic waste biomass

The ToSynFuel project concerns synthetic fuels and green hydrogen from organic waste biomass. The project will demonstrate a new integrated approach and process, presenting many advantages in terms of the flexibility of scale and delocalisation at the regional and local level. The flexibility of feedstock, quality and reproducibility of products independent of feedstock, plus the competitive low cost of the product are also discussed here.

During October 2018, the Intergovernmental Panel on Climate Change (IPCC) released its latest climate assessment report. This outlined the current extent of the global temperature increase and the measures that will be required to meet the Paris Agreement target of minimising further average temperature increase above pre-industrial levels to less than 1.5 Celsius (within the current century).

The message is stark and the measures required are severe and far-reaching. Global anthropogenic (human-generated) greenhouse gas emissions must fall by 80-95% by 2050 if we are to stand any chance of meeting the Paris Agreement. This will require a global shift in attitudes towards energy consumption and the use/reuse of resources. Society will require greener homes, greener and more sustainable energy production, cleaner industry, cleaner agriculture, reduced disposal or the increased reuse of waste, as well as cleaner transport.

ToSynFuel is a four-year project funded by the European Commission



which aims to contribute towards global climate change measures by applying a world-leading waste valorisation technology in conjunction with pressure-swing-adsorption and hydrodeoxygenation to produce clean and sustainable transport fuels and hydrogen from sewage sludge, both human and animal.

Thermo-Catalytic-Reforming (TCR®) is a patented valorisation process for residues developed by Fraunhofer UMSICHT. It is a highly flexible technology that can convert many forms of low-value residues (such as agricultural or industrial residues as well as municipal and human waste fractions) into petrol and diesel equivalents using low-cost, readily accessible plant components that require minimal maintenance.

ToSynFuel is focussed on the use of sewage sludge because it is a highly challenging feedstock that other valorisation techniques struggle to process and is of a plentiful, low-value supply that can be readily decentralised and dropped into existing value chains.

With its partners, the ToSynFuel project is building a demonstration plant at pre-commercial scale (over 7 tonnes per day) at a site in Hohenburg that currently locally dries and produces sewage sludge feedstock at around 10,000 tonnes per year.

If successful, this demonstration plant and the highly-scalable TCR® technology will pave the way for a follow-on project to develop a commercial-scale plant capable of processing around three tonnes per hour. With installations throughout Europe, TCR® could produce thousands of tonnes of green fuel per year from organic waste, saving over 80% in greenhouse gas emissions over the equivalent production of fossil fuels, therefore, contributing to the worldwide effort required to meet climate change goals.

This project has received funding from the European Union's Horizon 2020 Research and Innovation programme under grant agreement No 745749.

Total budget: €14 511 922,50

EU financing: €12 250 528,13

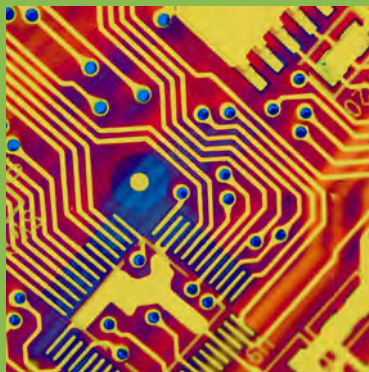
H2020-LCE-2016-RES-IA

Duration: 48 months (2017-2021)

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# Why wait? Fuel cells leading the global energy transformation today

Morry Markowitz, President of the Fuel Cell and Hydrogen Energy Association argues why should we wait when fuel cells are leading the global energy transformation today

The world is undergoing an energy transformation and with that, the demand for cleaner, more reliable power is growing. Fuel cells are answering the call – emerging as the ‘go-to’ technology solution for a wide range of market sectors, from transportation to stationary to portable/off-grid – and are enabling the transition to renewable energy around the world.

Fuel cells generate energy through an electrochemical reaction of hydrogen and oxygen, not combustion, and when pure hydrogen is used for fuel, the only by-products are water and useful heat.

From an energy security standpoint, reducing dependence on imported fuels is key. Hydrogen can be generated from domestic sources – from conventional fuels such as natural gas to biogas generated from landfills, wastewater treatment plants, industrial farms, or food processing facilities. Hydrogen can also be produced using electricity, from the grid or renewable sources such as solar or wind power, to split water.

A fuel cell will continue to operate as long as fuel is provided, ensuring continuous, reliable power, which is critical to so many industries, governments, and the citizens they serve. Stationary fuel cells can operate in tandem with – or independent of – the grid and have proved their resilience through several major storms and power outages, servicing communications networks, grocery stores and emergency shelters.

In addition to power, the by-product heat from a fuel cell can be captured and used at the end-user facility for heating or cooling, boosting overall efficiency to more than 90%. Fuel cells are also durable, quiet, and lightweight, allowing for flexible siting – inside, outside, underground or on the roof.

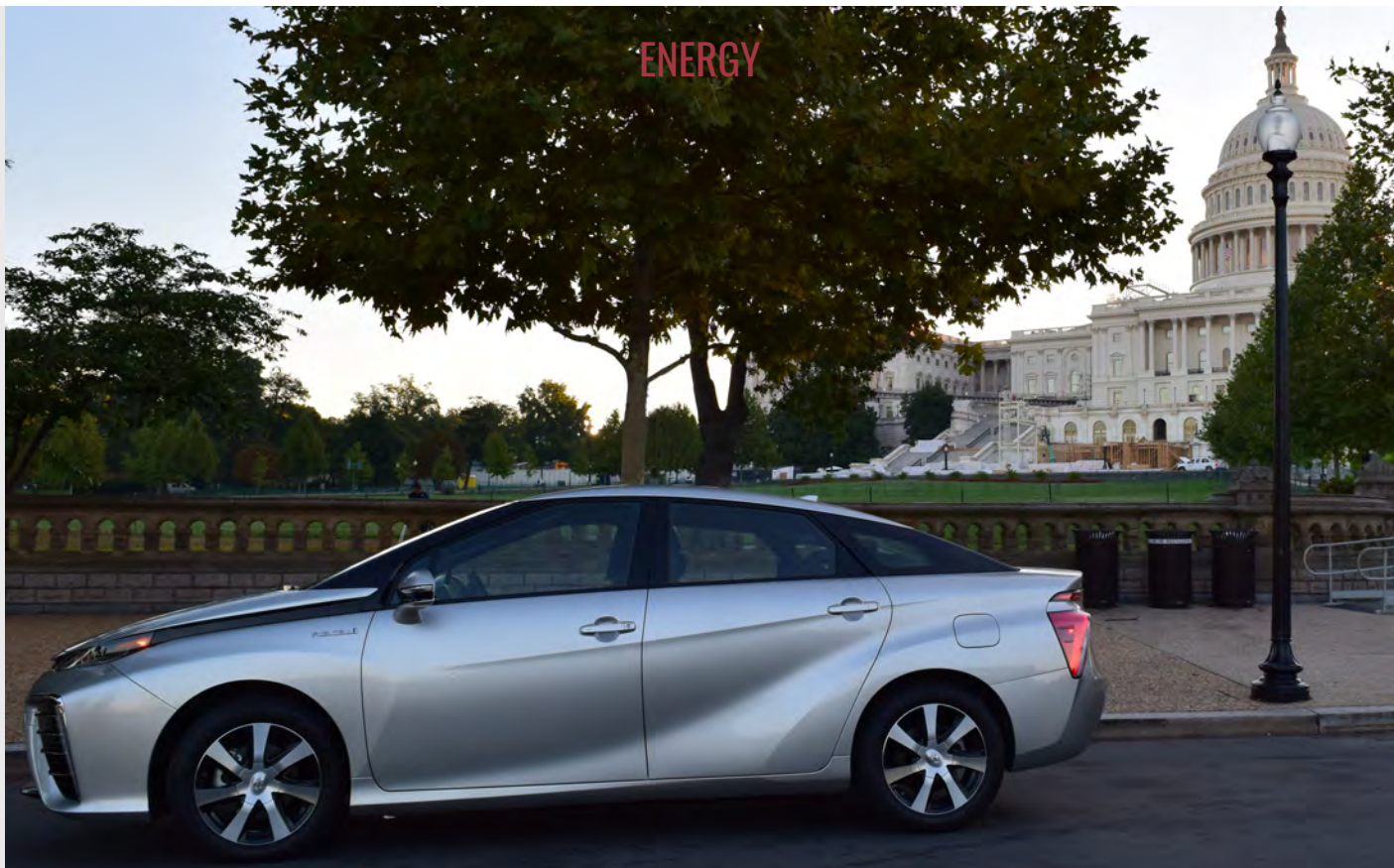


*Morry Markowitz, President*

Fuel cells can be scaled to virtually any size to fit any power need, which is why the technology is being deployed in a range of markets. Customers today range from some of the largest global corporations to mom-and-pop small businesses, as well as utilities, municipalities, military branches, and more. Fuel cells are currently providing power to retail sites, data centres, telecommunications and railroad networks, wastewater treatment plants, hospitals, universities, and other sites.

In the transportation and mobility sector, more than 23,000 fuel cell-powered forklifts are operating in warehouses and distribution centres across the U.S. and





fuel cell buses are transporting passengers in multiple states in the U.S., as well as numerous countries abroad.

Recent momentum and announcements in fuel cells for heavy-duty trucking and medium-duty delivery vehicles has spurred significant interest and activity from major companies as current demonstrations show the potential for the technology to make a big environmental and economic impact in this sector.

For individual consumers in Japan and parts of Europe, fuel cell systems can be purchased to power homes and apartments. In California and several countries around the world, zero-emission fuel cell vehicles from top automakers are available for sale or lease.

Collectively in all these markets, there are hundreds of thousands of fuel cells in operation around the world today, and the United States is out front as an international leader for this innovative technology. This success in the U.S. is due in large part to the support of committed state and local governments, as well as public-private partnerships, a committed industry manufacturing and exporting products, and a strong foundation of R&D through academia, the U.S. Department of Energy, and the National Laboratories.

As more customers experience the benefits of fuel cells, applications for these technologies are expanding

to include ground support equipment at airports and ports, mobile lighting, unmanned land, air and sea vehicles, remote and portable power for the military, and community micro-grids. New opportunities are also emerging, including in energy storage and power-to-gas, to help transition to the large-scale and world-wide adoption of renewable energy.

With a technology that can meet the size and power requirements of virtually any application, powered by a fuel that can be produced from both conventional and renewable feedstocks and a proven record of environmental and economic benefits, the potential of fuel cells is limitless.

Fuel cells are here today and already making a huge impact helping transition the world to a better tomorrow. ■

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# Research success in power-to-Gas (PtG): Renewable fuels from the sun to green gas

The Horizon 2020 project, STORE&GO opens their second PtG demonstration site concerning renewable fuels. The results of this project in Brussels are revealed to us here by Dr Frank Graf

In December 2017, the international community gathered in Katowice, Poland, to discuss how to protect the Earth's climate at the UN Climate Change Conference. The COP24 demonstrated once more that the participating nations must continue to work jointly on the biggest challenge of this century: implementing the Paris Agreement on climate change. Accordingly, greenhouse gases have to be reduced worldwide and drastically over the coming decades.

To reach a maximum reduction of emissions as soon as possible, no effort should be spared and all available technology paths should be considered. Renewable fuels, such as synthetic methane can play a vital role in the future European energy system. With that in mind, 27 partner organisations and companies from all over Europe collaborate in the STORE&GO <sup>(1)</sup> project to investigate the power-to-gas (PtG) technology. The project focuses on the integration of PtG into the daily operation of European energy grids to investigate the maturity level of the technology.

## The role of gas in the European energy system

To make politicians more aware that PtG technologies are the key enabler for a CO<sub>2</sub>-neutral future, STORE&GO partners intensified the political dialogue in Brussels. As part of a political evening in the European Parliament <sup>(2)</sup>, the project consortium discussed on October 17, 2018, with key stakehold-



ers from the European Commission, industry and research organisations the potential of the PtG technology.

"The technology is ready but needs to be tested under real conditions", commented Prof Dr Trimis, CEO of the DVGW Research Centre at Engler-Bunte-Institute of the Karlsruhe Institute of Technology (KIT), during the event. "Therefore, three demo plants are built and operated in Germany, Italy and Switzerland. This will allow (us) to demonstrate the technical maturity of PtG. The project will define a roadmap allowing politics to set an appropriate political framework, and industry to invest in this technology at a larger scale.

PtG is not only a technology for the large-scale energy storage of volatile renewable sources. It is also an instrument for efficient energy conversion. In the future, PtG allows for bridging

the mismatch between electricity supply by renewables and continuing demand for gas by the industrial and transport sectors", he continues.

The centrepiece of the discussions were the first results from the project. These deal with the life-cycle environmental impact assessment for PtG systems, the role of PtG in the future energy system, and an analysis of PtG licensing and regulatory frameworks in Europe, as well as in Germany, Italy and Switzerland. The results indicated that the carbon footprint from renewable methane can be more than 80% lower than the footprint of natural gas. Complex simulations of the future energy system showed a high probability that green gases will play an essential role in 2050. One of the findings is that the political framework is not yet ready to ensure a market uptake for PtG (for further information see the STORE&GO E-Book <sup>(3)</sup>).



STORE&GO political dinner in the European Parliament on October 17th, 2018

Dr Tudor Constantinescu, Principal Advisor of the European Commission – DG Energy, spoke about the role of PtG in the Energy transition from the perspective of the European Commission. He presented the major energy challenges in Europe, as well as the main policy developments in the EU regarding the European energy system, and specifically for energy markets and storage.

Furthermore, he highlighted the importance of sector coupling and the key role of long-term and large-scale storage and the advantages the PtG technology provides. Dr Constantinescu also pointed out the need to establish a regulatory framework that allows all relevant technologies to contribute to a flexible energy system.

## Green gas made in Italy

Within the STORE&GO project, the first experimental experiences are being gathered at the three demo sites, of which two are already producing methane: in Falkenhagen, Germany <sup>(4)</sup>, and the lately inaugurated plant in Troia, Italy. On September 27, 2018, about 50 people gathered in the Southern Italian region of Puglia to celebrate the opening of this innovative plant. The location area around Troia is characterised by a high share

of wind energy and high photovoltaics (PV) production capacities. This renewable power is used to generate hydrogen during the first step.

Within STORE&GO, the existing electrolyser unit was extended by a methanation reactor from the partner Atmosstat, where the renewable hydrogen is catalytically methanated using CO<sub>2</sub>. A special feature of the plant is the special CO<sub>2</sub> capture technology by the partner Climeworks. This unit absorbs and captures the required CO<sub>2</sub> directly from the atmosphere, therefore, closing the carbon cycle.

Also remarkable is a small-scale gas liquefaction unit by the partner Hysytech, that chills green gas to a temperature of -162°C into a liquid state, converting methane into liquefied renewable gas (LRG). This fuel can be transported and distributed to customers by truck. This makes the plant independent from pipeline access and demonstrates possible applications on islands. LRG can replace fossil LNG (Liquefied Natural Gas) as a green transport fuel for heavy-duty trucks or ships.

The plant will be tested and operated for at least 4,000 hours during the remaining time of the project until February 2020. Further industrial

partners of the Italian site are ENGI-NEERING, who are coordinating the activities in Troia, IREN Energia and Studio BFP. They are supported by their research partners CEA and Politecnico di Torino.

## The technology path towards a carbon-free future

The relevance of the Troia demo site for the energy transition was further explained at the political evening by Prof Dr Gerald Linke, CEO of the German Association for Gas and Water (DVGW). He explained a strategy on how to transition to a fossil-free energy system <sup>(5)</sup> by replacing coal and oil by gas, replacing fossil gas by renewable gas, and efficiently integrating the energy, heat and transport sectors by using PtG. Such, green gases can provide a complementary piece for the energy transition towards a fossil-free future, in the spirit of the Paris climate goals.

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- (1) The project is funded by the European Union's "Horizon 2020 research and Innovation programme".
- (2) For details, see [www.storeandgo.info](http://www.storeandgo.info) → 'News and Events'.
- (3) [www.openaccessgovernment.org](http://www.openaccessgovernment.org) → Stakeholders → Energy → STORE&GO.
- (4) See also Open Access Government October 2018, p. 333.
- (5) [www.dvgw.de](http://www.dvgw.de) → English → Topics → Gas and Energy Transition.



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# Improving the state of the ocean and ensuring a future for Europe's fisheries

Karmenu Vella, European Commissioner for Environment, Maritime Affairs and Fisheries charts his priorities to improve the state of the ocean and ensuring a future for Europe's fisheries

When I was entrusted with the portfolio of fisheries and maritime affairs, improving the state of the ocean and ensuring a future for Europe's fisheries became two of my top priorities. An ambitious endeavour with many obstacles to overcome where overfishing and plastic pollution are probably two of the most pressing issues.

The challenges are indeed significant, but so are the rewards. We all started down this path determined to ensure the environmental, economic and social sustainability of EU fisheries over the long-term. And I am happy to say we have made real progress.

In many parts of the EU, fish stocks are arguably in the best shape they have been in decades. Over the last 10 years, the number of stocks that reached sustainable levels has increased from five to 53 (out of 76).

In 2018, 97% of the volume of stocks managed by the EU alone and subject to full scientific assessment, have been fished sustainably. Concretely, this means fishermen only take out of the sea the maximum amount of fish that would not hinder the regeneration of the stock.

Our efforts are clearly paying off, but we have not yet reached our goal to bring fishing for all stocks at sustainable levels. Some species are more sensitive and more difficult to assess and manage than others. Such is the case of the deep-sea species, which are highly vulnerable and take a long time to grow and reproduce.

Over the years, deep-sea stocks became more and more depleted. The fishing pressure on most of these stocks is too high. The particularly difficult deep-sea environment makes it hard for the International

Council for the Exploration of the Sea (ICES) to do a detailed assessment. So, while these stocks are by nature vulnerable, we also have to take into account the additional uncertainty of limited scientific insight.

Therefore, we base our decisions on precautionary advice by the ICES to avoid further depletion of the stocks in the short-term and maximise the chances of reaching sustainability in the long-term.

For 2019 and 2020, the Commission put forward a proposal, endorsed by the Council, to reduce catch limits for several stocks, until their evolution shows a positive trend. The good news is that the reductions are smaller than in previous years. In some cases, Member States made additional commitments to adopt national measures to protect juveniles. It shows that we are heading in the right direction.

Even better, the positive evolution of the two stocks allowed us to increase fishing opportunities. It is another good indication that we are getting closer to bringing deep-sea stocks to healthy levels.

And this is good news for fish and fishermen alike, especially for the artisanal and small-scale fisheries that target deep-sea species.

We have seen that fishing sustainably pays off not only for the environment but also for the economy. This is why we are determined to ensure that we have healthy fish stocks in deep-sea waters, for the sake of our fishermen and coastal communities, their livelihoods, and for our marine ecosystems.

Now to our second very big challenge. No shore, no seabed is spared the presence of marine litter, and its effects are being felt throughout the food chain, from





Image © European Commission / Thierry Monasse

*Karmenu Vella speaks at the EU Environmental Footprint Final Conference "From Vision to Action"*

microscopic organisms all the way to our dinner plates. The problems are complex, there are gaps in our knowledge, but there is no doubting the urgent need to act.

Europe's marine environment is already protected by exacting standards, from agricultural rules and wastewater management obligations to laws that cover the delivery of waste in ports. But we know it's not enough, so we're stepping up the action with new legislation that firmly enshrines a Europe-wide effort to halt the littering of objects that end up in our seas.

The first EU strategy for plastics, adopted in the summer of 2018, should also help tip the balance. The aim is to rethink our approach to the material, stressing its value and adding incentives for plastics recycling. The new piece of legislation on single-use plastics that we proposed joins the dots between waste management, marine environment policies and efforts to clean up our seas. The Directive on Single-Use Plastics is also part of this strategy, targeting fishing gear, as well as the items most frequently found on beaches.

Much of the litter originates outside Europe, so we are also committed to supporting and assisting our international partners, and to lead on the topic in inter-

national fora, such as the UN, G7 and G20. Europe funds projects that monitor and assess plastic litter and its impacts, and measures to prevent and reduce the problem through a variety of funding instruments. Our proposal is being seen as a model for other countries to follow and India, for example, wants to abolish all single-use plastics by 2020.

In keeping with the global nature of these problems, the EU made 23 fresh commitments to improve the condition of our oceans at the Our Ocean conference in Bali in October 2018. This was backed up with an extra €300 million for EU-funded initiatives, including projects to tackle plastic pollution, make the blue economy more sustainable, and improve research and marine surveillance. This is part and parcel of Europe's determination to tackle the problem of litter while we still have time. ■

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# Green technologies gearing up globally in East and West

The EU has been a pioneer in green technologies for decades, but China is rapidly catching up in eco-innovation, explains Prof Dr Raimund Bleischwitz

The EU has been a proud pioneer in green technologies since the 1970s. International milestones such as the Paris Agreement on Climate Change signed in 2015 confirm leadership and ambitions. Yet, the EU has recently been crippled following concerns over migration and struggles with the state of the union itself – absorbed by managing Brexit and sweeping populism. As a result, the EU's pioneering spirit in environmental action seems to vanish, and forces of fragmentation appear stronger than attempts for integration. So, what's the evidence of green shifts and what trends may come up?

One needs to look at the wider picture of societal transitions to grasp the fundamental uncertainties and the ubiquitous 'age of anger' (Mishra Pankaj). Others call it a 'productivity puzzle' – a quest for the wellsprings of prosperity. For decades, if not centuries, labour has been the main driving force. The engine of growth based on labour has been stuttering in many countries, and the future challenges of Industry 4.0 – name it digitalisation and artificial intelligence – is likely to accelerate crisis.

The troubled state of the environment with tonnes of plastics polluting oceans and sea animals, historic droughts and other extreme weather events, call for a restart in efforts to think through productivity and prosperity. For a turnaround, societies will

need to reconsider productivity and move towards a circular economy (CE), one that creates public values through unleashing resource productivity. Fortunately, the Europeans are not alone any longer.

The hubs of innovation and change are shifting eastwards. China, Japan and South Korea have strong national strategies for enabling a circular economy and low carbon societies. After more than 15 years of being a frontrunner, the new Chinese policies enacted in 2017 introduce product redesign and the sharing economy, with value creation opportunities particularly for cities. Large-scale industrial parks such as Liuzhou and Kawasaki in Japan demonstrate radical emission reductions and cost savings through principles of industrial ecology and cascading energy use. New lighthouse projects such as Lingang City and its Low Carbon College, located close to Shanghai Disneyland to attract millions of visitors in the future, start to act as living laboratories for the next great transformation – towards a circular economy.

## Collaboration across movers and scalers, not confrontation

Geography and scale matter, as much as new modes of collaboration. The idea of a 'first mover' is often associated with a personality or a firm unleashing a Schumpeterian dynamic of overcoming barriers towards

becoming a champion; national systems of innovation would underpin such efforts. The innovation systems of the 21st century may look different. The new normal cuts across nation states. International collaborations may well be embedded in regional action across multiple stakeholders to test and integrate novel products into systems of provision – the electric vehicles in Chinese cities being a splendid example.

Yet, such case also demonstrates how transformation spreads from developing key technologies and testing new systems towards 'first scalers' in mass markets: green transitions are spanning continents and involve producers, consumers, and governments. China now constitutes 60% of all new electric cars in the world, and some observers expect a ban for gasoline cars as early as in 2022 – quite a disruptive shift and a nudge for Europeans as well as for industries to stay alert as second movers. Mission-oriented policies (Mariana Mazzucato) ought to be developed. Imagine a mobility being independent of oil in the year 2030, what a different world it would be.

No doubt, there will be winners and losers. However, the savings on purchasing and processing costs for energy, materials and water as well as on total costs to access are enormous, compared to returns on old-fashioned investments and linear business



models. Estimates done by the Ellen MacArthur Foundation count such savings equivalent to around 14% and 16% of China's projected GDP in 2030 and 2040, which altogether could enable more Chinese urban dwellers to enjoy a middle-class lifestyle with low environmental impacts. European findings give evidence for double-digit cost savings in manufacturing outweighing efforts in change and enabling investments into new products and services to the benefit of the people.

Key enablers are within the built environment and access to affordable housing, mobility and food, hence in line with key SDGs. New collaborations can bring along new and refurbished buildings following a modular and multi-functional design, with components being ready for reuse and digitally enabled sharing models. In energy, food and water, cities could become regenerative and recover nutrients for urban farming. Universities, labelled as 'one of the greatest institutional inventions of the past millennium' (Andy Haldane) have a particular role to play as providers of knowledge and social skills as well as facilitators for life-long learning across cultures. Blending traditional silos of knowledge and skills with grand challenges, novel solutions and upscaling them will be key in going beyond CO<sub>2</sub> reduction towards addressing resource interlinkages (the 'nexus') in a more holistic manner towards a circular economy and systemic eco-innovation.

## A green alliance between China and Europe

The China – EU agreement on a circular economy signed in 2018 has been a useful step in the right direction; we propose six actions for the way ahead:

- 1) Collaborations among cities and industrial parks, to include low carbon energy systems, circular buildings with recovery options for materials, shared zero-emission vehicles, and urban nexus innovations such as Alibaba's JuTuDi and working with circular economy utilities such as Veolia.
- 2) Ambitious CE standards for key product groups in construction, mobility and food that enhance affordability and sharing.
- 3) A regional Platform for information and better policy, combined with an action clearinghouse on CE initiatives, technology, and know-how transfer in order to practice what is preached.
- 4) Redesigning the 'one belt, one road' initiative towards a green EurAsia platform, with extended producer responsibility schemes, green supply chains, and creative solutions for the fossil fuel economies of Central Asia and for eco-innovations in Eastern Europe.
- 5) Coordinated market-based incentives towards removing harmful

subsidies, transforming the 'zombie industries' of cement and steel, and unleashing investments into CE and public values.

- 6) A Foresight Commission assessing pathways and options towards 2030 and beyond, with scenarios and modelling interacting with planning and stakeholders.

The years ahead will look brighter if opportunities of collaborations are being grasped and if people realise they benefit from tangible innovations on the ground and participate in change rather than feeling left behind.



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# Environmental approaches to regional security

Juri Martin from EuroAcademy offers his expert thoughts on environmental approaches to regional security

In many regions of the world, the renewable natural resources are being utilised faster than their natural rate of renewal and the regional environment is being abused in many other important ways as well. Moreover, the ecogeographical regions (ecoregions, regional approach, spatial planning) of the world are not generally delimited in synchrony with the political boundaries of the world.

## The concept of environmental security

Two major prerequisites must be satisfied to achieve environmental security:

- A *protection requirement*, that is, the quality of the human environment must be safeguarded;
- A *utilisation requirement*, that is, any exploitation (harvesting or use) of renewable natural resources must be carried out on a sustaining basis.

The problems associated with environmental security fall into a number of more or less distinct categories and sub-categories:

### 1. Problems associated with the protection and conservation of the environment:

- Avoidance of vandalism (wartime or other non-remunerative destruction);
- Avoidance of excessive pollution, that is, pollution in excess of the natural renewal or cleansing processes and;

- Avoidance of any permanent anthropogenic intrusion whatsoever in a modest number of special areas.

### 2. Problems associated with utilisation of the environment (ecosystem services):

- Avoidance of utilisation at rates beyond long-term sustainability, that is, in excess of maximum sustained yield or maximum sustained discard and;
- Avoidance of utilisation – in the event of past abuses – at rates that will prevent recovery of the degraded environment (recovery, moreover, that may well require human assistance).

The problems associated with environmental protection, conservation and utilisation will, of course, vary in detail depending upon the nature of the resource. Resources can conveniently be divided into the following categories:

- **Non-extractive resources**, including the land and its soil, water and the atmosphere and;
- **Extractive resources**, including non-renewable resources and renewable resources.

It must be stressed that all utilisation of the renewable natural resources must be carried out on a sustained-yield basis; and that all disposal of waste must be carried out on a sustained-discard basis (circular economy). Without

an inflexible commitment to the sustainable development of resources and the sustainable disposal of waste, there can be no environmental security.

**“It must be stressed that all utilisation of the renewable natural resources must be carried out on a sustained-yield basis; and that all disposal of waste must be carried out on a sustained-discard basis (circular economy).”**

Protecting the quality of the human environment implies the prevention of soil erosion, of air pollution and of water pollution in excess of levels that would jeopardise the public health. It further implies the maintenance of representative habitats in their natural state and the prevention of species extinctions. In those instances where environmental damage or deterioration of some sort is already prevalent, the protection of the human environment implies actions that would restore the damage, at least in so far as this remains possible.

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# Streamlining environmental compliance, despite Brexit turmoil

James Turner at Thomson Environmental Consultants argues that we must strive to continue streamlining environmental compliance, despite Brexit turmoil

With the need for new housing infrastructure in the UK, the demand for development has arguably never been higher than it is at this moment in time. However, this demand must be balanced against UK wildlife and environmental guidance to ensure that we create a landscape which meets the requirements of our population but also preserves our fragile natural landscape and protects native wildlife. The role of environmental consultancies is to provide expertise to ensure that developers meet their project objectives, whilst complying with environmental laws and planning consent requirements effectively.

The current legislative framework around protection of environment and wildlife in the UK is rightly comprehensive and detailed. UK wildlife laws, such as those laid down in the Wildlife and Countryside Act, give developers and ecologists a lawful basis to work from. In addition to legal requirements, structured environmental guidance published by Natural England and Non-Governmental Organisations (NGOs) sets out the good practice survey and developmental processes required for various environmental topics. Planning policy, such as that found in the National Planning Policy Framework (NPPF), sets out how decision makers should promote the protection and enhancement of the environment throughout the planning process, for example, refusing planning consent where significant harm to biodiversity cannot be avoided.

The NPPF also sets out how local planning policies and decisions should contribute towards not only protecting but enhancing, the natural environment. Through designing appropriate species-specific mitigation for any losses of habitat resulting from the proposed development, targeted species within the development area should be left in a better situation than they were originally found. The creation of new species-specific

habitat, improvement of existing habitat or translocation of animals into more suitable areas are all methods that can be used under current legislation, guidance and planning policy.

Taken together, environmental legislation, best practice guidance and planning policy provides a comprehensive and detailed but fragmented framework for compliance. Ultimately, for the developer, the framework for environmental compliance can be confusing and vast.

It is welcome that UK legislation and planning policy are also beginning to look at habitats at a county, or even country level rather than just at the site level, a change in approach which we and many others tend to wholeheartedly support.

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**“The streamlining of national and local planning policy would also increase simplicity and increase the rate of adoption by planners and developers while ensuring that local wildlife groups with an interest, continue to be consulted to encourage local involvement and incorporate more local knowledge into ‘core’ law and policy involved in the environmental work.”**

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The fragmentation of habitats can cause serious problems to an array of critically endangered species, an issue which arises from multiple developments within an area over a period of time. It is our view that the future approach of conservation and preservation in the UK should adopt the wider view, with a greater focus on strategic planning, protection and enhancement of the environment at a local level, as opposed to the development site level.

For example, linking up previously fragmented habitats to create a robust network of green infrastructure at a





county scale would greatly benefit wildlife. This approach should ideally be based over a longer-term view of the habitat changes in the county or across the country, to monitor and manage overall habitat loss and impacts on wildlife in a broader context.

We are now at a critical point - with the UK most likely leaving the European Union shortly. National laws arising from European Directives will need to be adopted/amended and, in time, new advice may need to be drafted once government ministers are more certain of where the environmental law will stand post-Brexit. However, this is an excellent opportunity to streamline existing wildlife laws under a single piece of legislation, reducing situations where many different pieces of legislation must be addressed, and duly highlighting the considerations of planning policy and best practice guidance produced by NGOs.

It should be noted, however, that this would actually be carrying on some of the work which was occurring

pre-Brexit, where district-level licensing was coming into play, for example, and more of an emphasis was starting to be placed upon the streamlining of wildlife laws. With regards to the Common Agricultural Policy (CAP), a new/amended agricultural policy could provide further opportunity to protect and enhance the environment, for example, through the provision of more tailored subsidies for farmers who provide environmental enhancements, again, an already expanding area pre-Brexit. This incentivised system could potentially be rolled-out to planners/developers in the same vein, creating a single robust and detailed system for all those who are amending the natural landscape to follow, potentially under a brand new regulatory body.

Prior reviews of protected species legislation, which were noted to be targeting this 'streamlined' approach, have effectively been put on hold, partially due to Brexit adding too much uncertainty surrounding wildlife law. However, future reviews could be taken further and could incorporate not only protected



species but their habitats to a greater degree. It is vital that leading UK environmental groups are consulted on the future decisions of what legislation to incorporate into this new act. This would ensure simplicity for both those who act to safeguard our environment and the developers who wish to ensure compliance. Ultimately it will hopefully lead to increased adherence to planning law and environmental guidelines.

Our view is that future mitigation guidelines should incorporate an approach where not only targeted protected species are benefitted, but also any ecologically sensitive species, to ensure mitigation is both at its most effective and that money spent is utilised to its full potential.

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**“The fragmentation of habitats can cause serious problems to an array of critically endangered species, an issue which arises from multiple developments within an area over a period of time. It is our view that the future approach of conservation and preservation in the UK should adopt the wider view, with a greater focus on strategic planning, protection and enhancement of the environment at a local level, as opposed to the development site level.”**

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The streamlining of national and local planning policy would also increase simplicity and increase the rate of adoption by planners and developers while ensuring that local wildlife groups with an interest, continue to be consulted to encourage local involvement and incorporate more local knowledge into ‘core’ law and policy involved in the environmental work.

The current use of local wildlife record centres as the first point of call for environmental groups looking at background protected species records in a given area is invaluable to inform all parties involved of potential ecological sensitivity. This becomes especially important when concerning the previously mentioned areas of district-level licensing, which is a process like many others which is limited by the availability of local protected species data. In time, this could be made more comprehensive and more environmental records should be gathered to inform this very important part of the development process.

Current laws and guidelines generally provide a more ‘minimalist’ approach to environmental adherence and mitigation levels, where there is no incentive for developers to go beyond the base levels required to appease biodiversity planning law. Of course, this can be understood where cost and time on the part of the developers are important – budgets and timelines must be met. Creating a system where legislation and methods are simpler to understand combined with incentivising going beyond base levels is a real opportunity to benefit our environment.

Leaving the European Union gives us the opportunity as a country to continue the already initiated idea of streamlining the existing environmental guidelines and associated planning laws, coupled with maximising the comprehension of environmental efforts. The inclusion of a new regulatory body to aid this throughout the Brexit transition and ensure a robust environmental agenda going forward would be of great value to the UK. However, until Brexit is completed the country appears to be positioned in a state of flux and unable to come to decisions. We do not want to see any watering down of what currently exists but rather a more effective system that is easier to navigate. In order to be as effective as possible, there needs to be the inclusion of all possible parties involved in the future of the environmental side of development in the UK. This will achieve a process whereby species don’t just survive but thrive. ■

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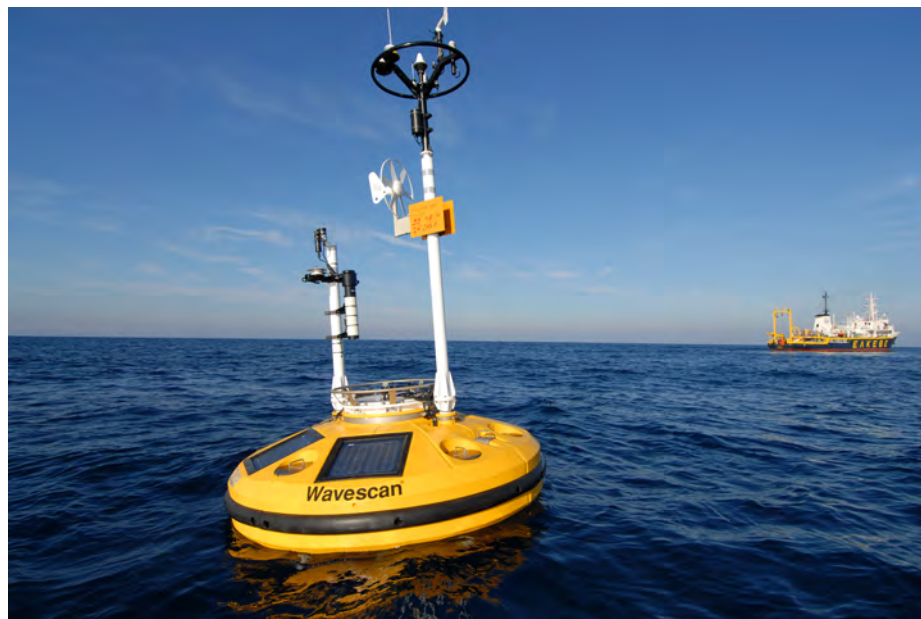
# Environmental research: A future for advanced marine LTER data

Ilaria Nardello from EMBRC-ERIC (European Marine Biological Resource Centre) details the future in store for advanced marine LTER data as an excellent example of necessary environmental research

The centralisation and harmonisation of marine LTER data lie ahead with EMBRC-ERIC working to develop data and knowledge repositories, e-infrastructure and genomic observations through a data access system and an analysis and data archiving platform.

Long-term ecological research (LTER) is used to identify changes in ecological variables over a function of time to understand ecological processes and relationships (Ducklow, Doney, & Steinberg, 2009; Knapp et al., 2012; Wolfe et al., 1987). A number of marine LTER variables are measured and range from water characteristics to nutrient concentrations to the diversity of organisms. The measurements can be analysed as one variable or multiple parameters and can be compared or combined to show relationships that would otherwise be unknown, such as the environmental status of marine waters or responses of community structure to changes in the environment.

Analyses in the past have used limited long-term biological parameters to separately study biotic and abiotic interactions, meanwhile, species abundance (combined with other factors) can give insight into the causes and effects of such change (Beaugrand, Brander, Alistair Lindley, Souissi, & Reid, 2003). The nuance of aggregating data for analysis over larger



spatiotemporal scales is due to the lack of coordination and standardisation in sampling, which results in spatial and temporal gaps, as well as marine stations and platforms operating at a local level (European Marine Board, 2018; Wolfe et al., 1987).

## Harmonising LTER data and research infrastructures

Efforts to harmonise LTER data originate from the necessity of interoperable data for analysis, although stations and institutions in Europe use different instruments and protocols to take measurements of LTER variables. Data itself is not the only system that is heterogeneous in the LTER data field, the accessibility of such data is also variant. Datasets are found on various information systems and infrastructures and

have different levels of procedures for accessibility, from the conditions of requesting specific data or clicking a link to downloading large files of LTER data. As LTER data is found in diverse locations online, the visibility of the data is reduced (Ilaria Nardello et al. 2017). In some cases, data of different variables from the same site are monitored by different organisations and, therefore, dispersed to different networks online. The same dataset may also be located in different networks and have different levels of accessibility, making it more complicated to aggregate long-term monitoring data.

Research infrastructures have formed to solve issues in research and the European Marine Biological Resource Centre (EMBRC-ERIC) has objectives to

develop data and knowledge repositories, e-infrastructure, long-term monitoring efforts and genomic observations through a data access system plus an analysis and data archiving platform (Ilaria Nardello et al., 2017). With the task of establishing and operating new or existing research infrastructures, an investigation into the consortium's long-term ecological research data capacity was conducted (S. Gras, 2018).

Findings from the research indicated that datasets are currently not FAIR ((F)ind, (A)ccess, (I)ntergrate and (R)euse) (GO FAIR Initiative). Instead of being accessible through one point, they are scattered across the World Wide Web. While there are plenty of LTER activities within EMBRC-ERIC with the numerous types of monitoring efforts, many are embedded into data products, which do not have the same ability to be manipulated nor aggregated in the way raw data does. The complexity of the data providers increases as each one is specialised in a specific region or type of data.

The consortium, the data providers and users can all benefit from centralising LTER data on the EMBRC-ERIC access portal. Developing the access portal to create an LTER data inventory, mentioned in the EMBRC-ERIC Data Management Plan will allow for seamless user experience and access (EMBRC-ERIC, 2017). Centralising data will increase the visibility of both the EMBRC stations and their data providers and create an opportunity for EMBRC-ERIC to develop a unique access point for LTER data. In doing so, LTER will be found more easily and research strategies will improve.

## The future of studying biodiversity

Similarly to the data networks, the LTER activities are largely independent

as are their methodologies, restricting the possibility of cross-analysis and, thus, studying biodiversity at a large scale. To advance the future of marine science, EMBRC-ERIC must advocate for developed capabilities of long-term data through standardisation or harmonisation schemes of methodology in data collection. The consortium can develop and maintain common standard quality practices (Ilaria Nardello et al., 2017), considering that on its own, "site-focused" monitoring cannot fulfil global monitoring efforts (Couvet et al., 2011). With installations of EMBRC-ERIC being in different geographic locations and, thus, having different ecosystems, they were found to specialise in varying aspects of marine biology and organisms.

Ensuring the harmonisation of methods for variables that can be collected by all stations will enable cross-analysis, as well as targeting specific variables to be standardised by stations that have similar ecosystems. EMBRC-ERIC has the potential to collaborate with other European and global infrastructures to increase its own visibility. With harmonisation, the methodology may not be identical but it can easily be accounted for in measurements and result in compatible datasets for appropriate data extrapolation (Kissling, Ahumada, et al., 2018). The harmonisation of datasets can begin with a set of specific variables and evolve to more parameters and methodologies. If applied at a larger range of biological variables, it will create better long-term ecological research and findings.

In the years to come, the international consortium can lead to improved LTER measurements. By beginning this initiative, EMBRC-ERIC can partake in the movement development necessary to further research and understanding of our environment through scientific breakthroughs.

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# Norway's approach to fisheries and aquaculture management

Norway's approach to fisheries and aquaculture management is placed under the spotlight in this article, with a focus on the thoughts of Ministry of Trade, Industry and Fisheries Director General, Vidar Landmark concerning this area of policy

By way of an introduction, we know that The Ministry of Trade, Industry and Fisheries in Norway takes responsibility for designating industrial and seafood policy with an eye towards the future.<sup>1</sup>

Ministry of Trade, Industry and Fisheries Director General, Vidar Landmark gave [a presentation entitled Vulnerable Marine Ecosystems](#), where he explains he heads up the Norwegian aspect of fisheries and aquaculture management policy. He underlines that while this is indeed a huge task, many resources are being put into this work in Norway. He says that the country has been living by and from the sea as long as people have been living in the region.

## The importance of long-term environmental sustainability

In his speech, Vidar stresses that Norway is quite dependent on their fisheries and as such, they have been very important for the livelihood of the country's coastal communities for many centuries and today, they play a very important role in the economy. Norwegian fisheries as an industry is a mature one, he explains, which is a very important economic sector in Norway. He goes on to expand this vital policy of the Ministry of Trade, Industry and Fisheries in Norway in his own words, including his thoughts on the importance of long-term environmental sustainability.

"Our fishing fleet, both the ocean-going and the coastal fleet are well adapted to our resource base. The reason why I say this is because this is a situation that gives us the possibility of implementing the regulations necessary for secure long-term sustainability when it comes to the harvested stocks and the unavoidable environmental footprint that is left by the harvesting activity.

"This is possible just because of the economic strength of our industry, giving us the authorities the luxury of being able to implement the regulations that actually have a negative impact on the economic outcome for the industry in the short-term, but which are necessary to secure the long-term environmental sustainability.

"We have a very strong belief that long-term environmental sustainability is the best foundation for long-term economic and social sustainability. If we take care of the oceans, the oceans will take care of us."

If you look at a map of Norway, there is, of course, a massive amount of ocean to take care of, Vidar explains to the audience. As the intriguing lecture continues, he underlines the importance of integrated ecosystem-based management plans for the ocean areas of the North Sea, the Norwegian Sea, the Barents Sea and the Lofoten Area. He adds that all relevant Norwegian authorities have cooperated on the development of these plans and that the purpose here is to provide a framework for the sustainable use of natural resources and ecosystems services derived from ocean areas. At the same time, maintaining the structure, functioning, productivity and diversity of marine ecosystems is important. Vidar then details more about the integrated ecosystem-based management plans in his own words.

"The integrated ecosystem-based management plans provide a cross-sectoral framework for the management of activities, to ensure that the total environmental pressure does not threaten the marine environment. These management plans are built on a very comprehensive set of knowledge, but they also reveal that there are considerable needs for further knowledge.



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“The knowledge base will, therefore, be strengthened through mapping, research and monitoring. Since 2006, we have spent a lot more money than I would care to think about on The Norwegian MAREANO Seafloor Mapping Programme. I will just mention that MAREANO maps depth and topography, sediment composition, contaminants, biological communities, habitats and waters. Hence the MAREANO Programme is important to discover and document our marine ecosystems.”

## Vulnerable Marine Ecosystems

The lecture then turns to focus on Vulnerable Marine Ecosystems (VME) and Vidar references, in particular, the North East Atlantic Fisheries Commission (NEAFC), who have the mandate to adopt fisheries management measures in its regulations in accordance with the precautionary approach and the ecosystem approach. In 2004, we find out that NEAFC ordered the closure of several areas in response to international calls for precautionary action to regulate deep-sea resources

and their habitats, including VME’s such as corals and sea sponges.

Vidar says that NEAFC has adopted additional measures on bottom fishing areas activities in the regulatory space and that their general approach to VME’s includes the rule that regulatory bottom fisheries can only take place in areas that are defined as existing bottom fishing areas on the basis of actual fishing taking place there in a specific reference period. This concept of existing bottom fishing areas is an important concept, he stresses. Outside of these existing bottom fishing areas, only exploratory bottom fisheries can be authorised and these are subject to strict restrictions, a point that Vidar details further.

“An extensive review of NEAFC’s regulation of bottom fisheries was carried out in 2012, although it was concluded that the regulation was in general, consistent with the resolutions from FAO at the General Assembly of the United Nations where improvements were





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made.<sup>2</sup> This resulted in the new recommendation on the protection of VME's, adopted in 2014. This recommendation includes all the general rules regarding the protection of VME's, as well as the details of what areas are considered as existing bottom fishing areas and what are the areas closed to bottom fishing. It also includes a nexus on VME data collection protocol, the assessment of exploratory bottom fishing activities and on VME indicator species."

These regulations are quite detailed but Vidar notes that many emanate from the work of at NEAFC and are then transformed into national regulations. He then tells us that the NEAFC recommendation has been implemented and adopted by Norway, who always flies their flag when undertaking bottom fishing activities in the areas as subject to these regulations. Furthermore, Norway has adopted a bottom fishing activity in the Norwegian economic zones, including the one in Svalbard, Vidar adds.

## Act on the Management of Living Marine Resources

It's important that the footprint within the harvesting is kept to acceptable limits, so we then find out that the Act on the Management of Living Marine Resources is built on modern principles which are incorporated into law, Vidar tells the audience.

"The law requires that we build a knowledge-based management and the fundamental principle is sustainable use, based on the best available scientific advice. Then you can ask what kind of sustainability are we aiming at? We are working to make sure that we can have continuous harvesting of viable stocks, in a such a way that we can meet the needs of the present without thereby compromising the ability of future generations to meet their own needs.

"Our Act also states that all harvesting and other utilisation of wild living marine resources shall be





carried out in such a way as to minimise impact. The law doesn't only regulate the harvesting of fish, but it also regulates the environmental side of fishing."

In short, we find out that the Act gives the necessary legal basis to take environmental consideration, as well as giving the legal tools to implement regulations based on environmental considerations. He also says that Norway's Department of Fisheries and Aquaculture can prohibit harvesting in certain areas, as well as certain types of gear or

they can regulate devices used in connection with harvesting. The design of gear is an important part of making an environmentally friendly future for fisheries, we discover.

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**"We have a very strong belief that long-term environmental sustainability is the best foundation for long-term economic and social sustainability. If we take care of the oceans, the oceans will take care of us."**

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"In 1999, we implemented our first regulation explicitly aimed at protecting cold water coral reefs in Norwegian waters which we had just started mapping. A number of these are now...marine protected areas, according not to the general legislation on the protection of nature but according to our own Act on the Management of Living Marine Resources.

"This is also an important part of the Norwegian management system, we have tried to apply a holistic

approach – making sure that the use and protection of nature are two sides of the same matter – not competing interests. Shall we succeed in protecting nature? The protection must be an integrated part of the resource management, so those who manage and harvest from nature must respect the value of nature in itself. This is the core of ecosystem-based management, to see the interactions of the different parts of the ecosystem.

### Closing thoughts

Vidar concludes that in the same way, the core of knowledge-based management systems is just that – knowledge. It's vital that the necessary knowledge is had by the Ministry of Trade, Industry and Fisheries in Norway so that they can make the right decisions, taking the principle of a precautionary approach. He adds that the stocks rank amongst the best managed in the world, which is the result of management and cooperation between Norway and Russia based on more than 100 years of scientific work and cooperation.

"Based on the revision of the Common Fisheries Policy (CFP) of the European Union (EU) we hope that we can achieve similar results in the North Sea. It all depends on the willingness to act according to scientific advice – that has been and will be the core element of our approach to fisheries management and sustainable fisheries." <sup>3</sup>

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# The utilisation of pelagic fish: Challenges and possibilities

Turid Rustad from the Department of Biotechnology and Food Science, NTNU, reveals the challenges and possibilities when it comes to the utilisation of pelagic fish, including catch that is used for human consumption

**P**elagic fish are fish living in the pelagic zone of the ocean or lakes. The pelagic zone is the largest habitat on earth and pelagic fish, therefore, encompass a wide variety of different species. They are categorised as coastal or oceanic depending on the depth of the water they live in. The coastal pelagic fish usually live around depths up to 200 meters while the oceanic live at depths below the continental shelf.

Pelagic fish species such as anchovies, sardines, shad and menhaden belong to the coastal pelagic fish while mackerel, tuna, swordfish and sharks belong to the oceanic group. However, there are no strict boundaries between the groups.

The world population is growing leading to an increased demand for food. To meet this increasing demand more of the food needs to come from the ocean. Today around 3% of the food supply comes from the oceans while around 17% of animal proteins come from the ocean.

Seafood is a good source both of high-value proteins and also valuable lipids. Most of the fish stocks are already fully fished or overfished so there is a need for a better utilisation of the catch. This includes both reducing waste and increasing the amount of the catch that is used for human consumption.



On a world basis, there has been an increase in the fish consumption in the population going from 9 kg per capita in 1961 to 20.2 kg in 2015 – the average annual increase in fish consumption is higher than the increase in the population and is also higher than the growth in meat consumption (FAO state of world fisheries 2018). In Europe, seafood consumption was around 24 kg per capita in 2016. There is a large variation from country to country with a fish consumption of only 5.2 kg per capita in Hungary and 57 kg per capita in Portugal.

Tuna makes up one of the main products that is consumed in Europe and is mainly consumed as canned tuna but

herring is also among the main fish products consumed in Europe. Pelagic fish species such as herring and mackerel are also among the main species exported from the EU. The total amount of small pelagics caught in the EU in 2016 was around 1,800,000 tons and the import and export were 600,000 and 690,000 tons respectively. The consumption of these species was around 1,700,000 tonnes.

## **Pelagic fish – a valuable food source**

Most of the Atlantic herring and mackerel landed in Norway and Ireland is frozen and exported (600,000t) to other countries for processing. Most of the Baltic pelagic fish (sprat and

herring) is used for fish meal because of the lack of a consumer market.

Pelagic fish is a valuable food source due to its high nutritive value and essential nutrients such as long-chain omega-3 fatty acids – docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA), fat-soluble vitamins (E and D) and easily digestible proteins. However, the healthy omega-3 fatty acids are highly susceptible to oxidation resulting in loss of nutritional quality and formation of oxidation products with a negative impact on consumer acceptance.

Minimising oxidative deterioration of lipids during processing and storage is, therefore, highly important to deliver safe and healthy products. Fish contain high-quality proteins, with high digestibility containing all essential amino acids. During processing, the proteins can lose functional and chemical properties reducing digestibility and nutritional value. In pelagic fish, the control of histamine formation (scombroid poisoning) is important for safety.

The lifestyle and dietary patterns of people are changing. In the western world, the more time-stressed lifestyle has led to an increased intake of processed and fast food. Today there is an increasing consumer demand for convenient, healthy food that at the same time is more fresh-like (less processed) but still are safe and have a long shelf life. This necessitates the development of and adaptation of new processing and preservation methods, as well as the development of new minimally processed foods where the valuable nutrients are well preserved.

## Pelagic fish for human consumption

Using pelagic fish and meeting consumer expectations for healthy food, will increase the use of pelagic fish for human consumption will both improve population health but also be beneficial for local fish processing.

**“The world population is growing leading to an increased demand for food. To meet this increasing demand more of the food needs to come from the ocean. Today around 3% of the food supply comes from the oceans while around 17% of animal proteins come from the ocean.”**

Pelagic fish is highly perishable and is usually preserved by frozen storage. Several studies on frozen storage have shown that frozen storage at – 25°C to –30°C which is the recommended temperature for frozen storage of fish products in Europe will preserve the quality of the valuable lipids limiting the degree of lipids oxidation. However, studies on frozen stored mackerel have shown that the proteins will oxidize during long-term (>7 months) frozen storage. Oxidation of the proteins may lead to reduced sensory (functional) properties such as texture, gelling and become oxidized.

The shelf life of chilled stored mackerel is very short and after nine days of chilled storage, the content of biogenic amines (histamine) was too high, thereby, jeopardising the safety of the raw material.

When it comes to superchilling at temperatures around –2°C, studies on salmon have shown that superchilling can double the shelf life. Studies on the superchilling of mackerel in the

project ProHealth (Preserving the positive health effects of pelagic fish) have shown that superchilling can lead to increased microbial shelf life, but there is a need for optimisation to preserve the sensory quality of the fillets.

High-pressure processing has also been shown to be a promising method to increase the shelf life of smoked mackerel. Sous-vide (under vacuum) cooking uses lower and controlled heating temperatures leading to preservation of both quality and nutritional components. This method can, therefore, be used to prepare ready to eat/ready to cook products where the healthy components are preserved.

The development of ready-to-eat or ready to cook products from pelagic fish can result in a higher fish intake in the population – which could contribute to a higher intake of omega-3 fatty acids and also provide many other essential nutrients such as vitamins and proteins.

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# The environment: Clean water is life, health, food, leisure and energy

Hans Bruyninckx, Executive Director of the European Environment Agency (EEA) argues that clean water is life itself, but also our health, food, leisure and energy

**W**ater covers more than 70% of the Earth's surface. It was with water that life on Earth started, so it is not surprising that all living things on our blue planet need water. Clean water is, in fact, many things: it is a vital need, a home, a local and global resource, a transport corridor and a climate regulator. And, over the last two centuries, it has become the end of the journey for many pollutants released to nature and a newly discovered mine rich in minerals to be exploited. To continue enjoying the benefits of clean water and healthy oceans and rivers, we need to fundamentally change the way we use and treat clean water.

Water is home to millions of species, ranging from the tiniest organisms measured in microns to blue whales up to 30 metres long and weighing up to 200 tonnes. Every year, new species are discovered in the depths of the oceans. The oceans and seas also play a key role in the global climate: they are the largest carbon sink and capture carbon dioxide from the atmosphere. Ocean currents help warm and cool different regions, making them more inhabitable. Evaporation from warm seas can fall as rain or snow across the globe, sustaining life on land.

For us humans, clean water is not simply a vital need for our bodies, it is also a resource we benefit from every day. At home, we use it for cooking, cleaning, showering and flushing. Our food, clothes, mobile phones, cars and books all use water in their production. We use water to build our homes, schools and roads, and to heat buildings and cool power plants. With the electricity we generate from its movement, we light our cities and our homes. On a hot summer day, we dive into the sea or go for a stroll by a lake to cool off.

Water is also a means to connect and move people and

goods. It offers a natural transport network around the globe, connecting not only coastal cities but also inland cities along navigable rivers, enabling global trade. Our t-shirts, coffee beans or laptops produced in the Americas, Africa or Asia might be transported to Europe by ships. In other words, water is present in every aspect of our lives.

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**“Climate change is projected to impact the availability of water in Europe, putting additional pressure on southern regions already facing water stress. Other parts of Europe are expected to face more frequent flooding events, while low-lying regions are at risk from storm surges and a rise in sea levels.”**

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Unfortunately, the way we use and treat this precious resource not only impacts our health, it also impacts all life that depends on water. Pollution, over-exploitation, physical alterations to water habitats and climate change continue to undermine the quality and the availability of water.

## **We change the nature of water**

When we take water from its source and use it, we almost always alter various aspects of it. We straighten rivers, build canals to connect seas and rivers, and construct dams and levees to cater for our water use. Groundwater extracted from aquifers could be transported hundreds of kilometres to be delivered to our homes. Once used, it can be contaminated by chemical substances (e.g. phosphates used in cleaning products), plastic microbeads or cooking oil. Some of these pollutants and impurities can remain in the water even after undergoing advanced wastewater treatment processes. In the case of agriculture, water used for crops can contain residues of chemicals used in fertilisers and pesticides. After being used and sometimes treated, some of this altered water returns to a water body.



Even air-borne pollutants released by transport and industry can be deposited on rivers, lakes and seas and can impact water quality. Our water use can alter the temperature and salinity levels of oceans. The water used for cooling in the energy sector can be significantly warmer than the water abstracted. Similarly, desalination processes can release brine with high salt concentrations back to the marine environment. In the end, what we return to nature is often very different from what we extracted. Moreover, we do not always return it to where we extracted it.

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**“Unfortunately, the way we use and treat this precious resource not only impacts our health, it also impacts all life that depends on water. Pollution, over-exploitation, physical alterations to water habitats and climate change continue to undermine the quality and the availability of water.”**

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## Water quality matters

During the last four decades, Europe has made significant progress in regulating its water quality, treating its wastewater and protecting its marine and freshwater

habitats and species. EU policies address a wide range of issues from drinking water, urban wastewater, protection of habitats, designating marine protected areas and bathing water quality to floods, single-use plastics, industrial emissions and restrictions on the use of hazardous chemicals. These specific pieces of EU legislation are strengthened by overarching programmes and legislation, such as the Seventh Environment Action Programme, the Water Framework Directive and the Marine Strategy Framework Directive.

And Europeans care about the quality of their water. It is no coincidence that the first ever EU citizens’ initiative, namely [Right2water](#), which was supported by more than 1.8 million signatories, was on water. Awareness-raising schemes combined with water-efficient technologies and investments in leakage management have resulted in real water savings across Europe. The total amount of water abstracted in Europe has decreased by 19% since 1990. Today, more than 80% of the European population is connected to an urban wastewater treatment plant, which significantly reduces the amount of pollutants entering water bodies.



Our [recent report](#) on the state of water shows that about three-quarters of Europe's groundwater bodies have good chemical status: they are clean.

Regular monitoring of bathing water quality showed that about 85% of the EU's bathing sites monitored in 2017 were 'excellent'. More than 10% of Europe's seas have been designated as marine protected areas to help preserve marine species and habitats. These are all very encouraging improvements. Yet, despite the progress made, the ecological and chemical statuses of Europe's surface waters continue to cause concern.

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**“Water is home to millions of species, ranging from the tiniest organisms measured in microns to blue whales up to 30 metres long and weighing up to 200 tonnes. Every year, new species are discovered in the depths of the oceans.”**

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Of surface waters, only about 39% achieved the EU target of minimum 'good' or 'high' ecological status during the 2010-2015 monitoring period, while 38% achieved 'good' chemical status. Poor chemical status arises partly because pollutants (e.g. nitrates from agriculture) do not just disappear. Water absorbs and moves pollutants around and they end up accumulating in lakes and oceans. Many rivers have been physically altered or impacted by human activities, affecting fish migration upstream or sediment flow downstream.

Many marine fish stocks are over-exploited, threatening the survival of entire fish populations. Invasive alien species spread by ship transport or through canals, endangering local species. Marine litter, dominated by plastics, is found in all corners of the world from the Arctic to uninhabited islands in the Pacific. And, unfortunately, even if we stop new pollutants from entering water bodies, we face the legacy of all the pollutants released to water decades or, as in the case of mercury, centuries ago. And future generations will face the legacy of our releases.

### **Coping with scarcity and excess**

Compared with many parts of the world, Europe has relatively abundant freshwater resources. However,

these resources are not evenly distributed across the continent. In fact, according to our estimates, about one-third of the EU territory is exposed to water stress in which the demand exceeds the available supply for a certain period.

Climate change is projected to impact the availability of water in Europe, putting additional pressure on southern regions already facing water stress. Other parts of Europe are expected to face more frequent flooding events, while low-lying regions are at risk from storm surges and a rise in sea levels. Cities and regions are at the forefront of actions on the ground and are implementing measures, ranging from leakage reduction and water reuse to incorporating blue and green areas in urban areas, to minimise flooding risks and water damage.

Some key economic sectors, such as agriculture, use significant amounts of freshwater. In fact, during the spring and summer months, agricultural activities might be responsible for more than half of the water use in parts of southern Europe. Similarly, popular tourist destinations, including small islands in the Mediterranean, might need to provide water for thousands of visitors, putting considerable pressure on their already scarce water supplies.

### **A local and global resource**

Mass tourism is not the only time local water resources come under extra pressure because of non-local users. Global trade enables consumers to use natural resources, including water, from all parts of the world. French wine exported to China also 'exports' the water used in growing the vines and making the wine. Likewise, goods imported into Europe also import 'virtual water'.

In many ways, water is a local resource. Changes to water quantity or quality have direct impacts on the local environment and local population. But water as a whole is also a global body – a common good shared by everyone and all living things on our planet. Water moves across countries and connects continents physically and culturally. Because many large water bodies are connected, what can start as a local problem can



become one of many contributors to a larger problem. Conversely, a global problem, such as plastics or higher water temperatures in the oceans, can have more severe impacts locally.

This local-to-global nature of water demands cooperation and governance structures that match the scale of the challenge at issue. It is not surprising that many EU policies on freshwater and the marine environment emphasise regional and global cooperation. The EU is an active player in governance structures, ranging from the United Nations' Sustainable Development Goals to regional cooperation structures, such as the International Commission for the Protection of the Danube River or the OSPAR Commission for the North-East Atlantic. In recent years, governance structures have rightly involved non-state actors, such as large fishing companies, to ensure the sustainable use of water resources.

Faced with growing demands from competing users, it is clear that the path to the sustainable use of water and its resources goes through efficiency, innovation, preventing waste (e.g. reducing leakage), reusing, recycling – all key components of a circular economy. In fact, when we save one resource, such as water, we save on all others.

## Knowledge to help shape future policies

The European Environment Agency works with environmental information. A complex and inter-connected topic such as water requires different data streams, in-depth and systemic analysis, and close collaboration with networks and institutions. The EEA brings together all this knowledge on Europe's environment and informs policymakers and the public.

Over the last four decades, in line with EU legislation and reporting requirements, Member States have put in place extensive monitoring structures. Thanks to these efforts, our knowledge and understanding of the issues and trends relating to the environment, including water, are much more detailed and comprehensive. We can now have an integrated analysis of what drives change, what is changing and how. We can identify

effective measures on the ground and build networks to share this information.

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**“Regular monitoring of bathing water quality showed that about 85% of the EU's bathing sites monitored in 2017 were ‘excellent’. More than 10% of Europe's seas have been designated as marine protected areas to help preserve marine species and habitats. These are all very encouraging improvements. Yet, despite the progress made, the ecological and chemical statuses of Europe's surface waters continue to cause concern.”**

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This knowledge will be instrumental in shaping future EU policies on water. Some key components of water legislation, including the Water Framework Directive and Urban Waste Water Treatment Directive, are being evaluated and might be subsequently amended. Given the vital role of water in all aspects of our lives, a more integrated policy approach will help us protect and preserve what makes our planet unique: water.

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# The adaptation of coal for green future: Making the black greener

The adaptation of coal for green future is detailed here by Aleksander Sobolewski and Anna Kwiecińska from the Institute for Chemical Processing of Coal in Poland

In modern Europe, access to energy, water and other civilisation goods is regarded as a basic need rather than a privilege. The European economy, energy system and industry, have grown mainly on coal, and as such, are mature and ready for their green transformation, which, however, should be done with the greatest attention to maintain a safe and stable energy supply.

In recent years, we observe the introduction and stepwise increase of the share of alternative and renewable energy sources and fuels in the energy cycle. On the other hand, many developing countries look at coal as the basic fuel for their growing economies.

There are also developed regions, which still focus their economies on coal and as such, they are willing to adapt their systems towards a more efficient and environmentally improved coal use. For over 60 years, the Institute for Chemical Processing of Coal has actively participated and experienced changes and challenges related to the coal sector. Hence, considering the current social and environmental requirements accompanied by worldwide trends in the market and in the economy, we are ready to state that global innovation will be based on clean coal technologies. We believe that the world simply needs coal. Our role, as researchers, is to take actions to minimise environmental effects resulting from coal use.

Moreover, together with authorities, in developed countries, it is also our responsibility to support developing regions in their growth, and to assure this growth integrates all, social, industrial and environmental requirements. To provide reliable and efficient solutions for coal, or more generally, for carbon-based systems, as both the technologies developers and suppliers, we need to have both, access to knowledge and the opportunity to gain the experience, and this is exactly what forms the main goal of the Institute.

## Research priorities in the field of coal

To reach this goal, since 2012 Institute for Chemical Processing of Coal operates Clean Coal Technologies Center, unique in Europe research centre equipped with laboratories and installations for thermal processing of not only coal but also biomass and alternative fuels at minimum CO<sub>2</sub> emission. In the Center, we are able to apply different emission-limitation solutions to different technologies and improve them toward desired process parameters and acceptable environmental effects.

We lead our research in regards to all stages related to the effective and reasonable use of coal and other carbon-based fuels. Our centre possesses the complete line of fuel processing, starting from facilities for fuels preparation, through their thermochemical processing by, for example, combustion

or gasification, up to process and flue gases cooling and cleaning, including CO<sub>2</sub> capture.

Moreover, we focus not only on industrial coal use but also on its utilisation in terms of residential heating boilers. These actions allow us to deliver the innovative knowledge and technologies that support the coal and carbon-based industries and as such, ensure the efficient use of fossil, renewable and alternative fuels. The effective participation of the Institute in this innovation chain is our greatest challenge and at the same time, it is an honour.

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**“...the development of novel methods and sharpening of requirements for improved environmental effect of industrial plants creates new challenges, especially in reference to water. We are increasingly aware that water is a valuable resource, and its reasonable and sustainable use and management is our responsibility.”**

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## Not only the energy, not only the air

Coal is also an extremely important feedstock for steel production. Indeed, annually approximately 1,000 Mt of coal is consumed worldwide to produce coke, which is next used in blast furnaces for the recovery of iron from its ores. The long-term experience and cooperation of the Institute with coking plants make us aware of the challenges faced by the coal sector. One of them is the proper treatment and utilisation



of coke oven wastewater formed during coke oven gas cooling. Coking plants have made a huge leap towards environmentally acceptable practice within which coke oven wastewater treatment was improved by the introduction of biological systems.

However, in wastewater, there are toxic substances, which are not only resistant to bio-decomposition, but also need to be removed prior to it, in order to assure effective and stable operation of the biological treatment stage.

Moreover, the development of novel methods and sharpening of requirements for improved environmental effect of industrial plants creates new challenges, especially in reference to water. We are increasingly aware that water is a valuable resource, and its reasonable and sustainable use and management is our responsibility.

In industry, the main idea is to close water loops and to use water recovered from side streams available at a plant. At our Institute, we have the opportunity to coordinate the project

entitled "The innovative system for coke oven wastewater treatment and water recovery with the use of clean technologies" (acronym: INNOWATREAT), co-financed by The Research Fund for Coal and Steel.

## **Innovative approach for conventional design**

The INNOWATREAT project aims at elaboration of a set of solutions suitable to be applied at existing coke oven wastewater treatment sites. There are two main goals of the project. The first is the improvement of toxicants elimination from coke oven wastewater, accompanied with neutrality concerning stream salinity. This is to be obtained by innovative flotation and electrocoagulation processes.

The second is the recovery of the technological grade water from purified coke oven wastewater, which can be done by introducing a proper configuration of membrane separation techniques. To achieve these goals, within the project we have the pleasure of cooperating with national and foreign research and industrial units (Wrocław University of Technology, Akvola Tech-



nologies, Cracow University of Technology and Czech Technical University in Prague).

Moreover, we would like to acknowledge the support from The Research Fund for Coal and Steel and from Polish Ministry of Science and Higher Education, without which the project would not have been performed. The results obtained up to the present demonstrate that we are on a good road, but we still need to focus on scale upon efficiency and an acceptable economical balance. Nevertheless, we are proud that we may create the basis for the next-generation of industrial wastewater treatment methods – focused on closing the water loops and of course, enabling sustainable water management.

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# The USGS Earthquake Hazards Program

William Leith, Senior Science Advisor for Earthquake and Geologic Hazards at U.S. Geological Survey (USGS) explains the important aspects of the USGS Earthquake Hazards Program

September 2018's earthquake and tsunami disaster in Sulawesi, Indonesia, is our most recent reminder of the devastating power of large earthquakes. With a death toll exceeding 2,000 by recent estimates, this complex disaster, which included widespread ground failure that buried large parts of the city of Palu (pop. 335,000), now ranks among the worst earthquake disasters of the past 100 years.

It could happen here. Although Americans have not experienced a major earthquake disaster in nearly 25 years, since the 1994 earthquake that struck Northridge, California, the Federal Emergency Management Agency (FEMA) recently estimated that, when averaged over decades, annual earthquake losses in the U.S. are \$6.1 billion, with nearly half of Americans living in areas vulnerable to strong shaking in future earthquakes.

Yet earthquake losses can be reduced by improving the resilience of buildings, bridges and other structures, and by taking quick action when the ground starts shaking. Preparedness, mitigation, and informed response can reduce deaths, injuries, and economic losses from earthquakes, tsunamis, and earthquake-induced landslides and soil liquefaction. In other words, informed and proactive communities can save both lives and money.

To help reduce losses from earthquake hazards, the USGS Earthquake Hazards Program (EHP) supports a highly coordinated set of monitoring, hazard assessment, applied research, and risk communication activities nationwide. We provide the nation with a growing suite of rapid earthquake information products, deliver regional and national seismic hazard assessments, conduct targeted research to improve these functions, and coordinate post-earthquake investigations to understand better the effect of earthquakes.

The USGS program is the applied earth-science component of the four-agency National Earthquake Hazards Reduction Program (NEHRP). Through NEHRP, the USGS partners with FEMA, the National Science Foundation, and the National Institute of Standards and Technology to reduce earthquake losses (both life and property losses) in the U.S.

Response organisations require actionable earthquake information. The EHP monitors the nation's earthquakes via the Advanced National Seismic System (ANSS) which includes regional seismic networks operated by university partners. ANSS data, combined with data from the Global Seismographic Network, which the USGS co-supports with the National Science Foundation, is delivered in real-time to the NOAA Tsunami Warning Centers, enabling tsunami alerts throughout the Pacific Rim, including Alaska, Hawaii, Washington, California, and U.S. Territories, and in the Caribbean.

Through the National Earthquake Information Center (NEIC), we provide 24x7 reporting on domestic and global earthquakes and deliver rapid earthquake impact and situational-awareness products to support emergency response (the EHP website can often host more than 10 million visitors per month!). The NEIC catalogues more than 20,000 earthquakes a year, from imperceptible ones to great earthquakes that shake the whole globe. We also develop improved methods to improve the quality and timeliness of real-time earthquake information. We communicate earthquake information to the public and to key stakeholders that include federal and state emergency response agencies, disaster relief organisations, operators of utilities and lifelines, and local communities at risk.

ANSS earthquake products help governments and



*Damaged portion of the Golden State Freeway at Gavin Canyon.  
Northridge Earthquake, CA, January 17, 1994*

humanitarian groups to decide how to respond in times of crisis. Rapid situational awareness of an earthquake's severity is used across the response spectrum: from how quickly search-and-rescue teams have to pack their bags, to whether or not a metropolitan area should shut down its mass-transit-rail system. Hundreds of key responders, from the Red Cross to the White House to the United Nations, rely on the USGS to tell them exactly how severe an earthquake is and look to our models for the scale of potential impacts.

The EHP also maintains the USGS National Seismic Hazard Model, which describes the likelihood and potential impacts of earthquakes nationwide, and which serves as the basis of seismic provisions in building codes. We deliver each model update to the Building Seismic Safety Council, which develops building code updates, and we maintain associated databases and tools that are widely used for site-specific engineering design and seismic risk analysis.

The EHP also conducts and supports applied field, laboratory, and theoretical research on the causes, characteristics, and effects of earthquakes. Furthermore, we support relevant research by expert partners in academia, state agencies, and the private sector via competitive grants and cooperative agreements.

The latest development in earthquake safety is earthquake early warning (EEW). By recording an earthquake near its origin, one can quickly estimate its size and broadcast a warning ahead of the quake's strong ground shaking. The USGS and our university partners have built and are now testing an EEW system for the U.S. West Coast, called "ShakeAlert™", which will begin initial alerting in the next few months. Similar systems in Japan, Taiwan, Mexico, and elsewhere have proven the utility of early warnings and demonstrated that there is demand for these alerts.

So, if you live in California, Oregon and Washington or have family and friends there, or even plan to visit, in the near future you will be seeing EEW apps that receive USGS ShakeAlerts. Then, when an alert arrives, duck, cover and hold on! ■

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# Earth science: The Search for the Origin of Life

Friedemann Freund, Professor at the SETI Institute/NASA Ames Research Center provides a fascinating look at an aspect of earth science that concerns the search for the origin of life itself

I, Friedemann Freund, started out studying mineralogy and crystallography, had my first academic position as Assistant Professor in Chemistry at the University of Göttingen in Germany, moved on to a professorship in the Geosciences at the University of Cologne, also in Germany, and came in the mid-1980s to the NASA Ames Research Center in California, U.S., and joined the Physics Department at San Jose State University as an Adjunct Professor.

My interests have always gravitated around defects and impurities in crystals, in particular, those that arise from the interactions of minerals with the common gas-fluid components water, carbon monoxide and dioxide, nitrogen, and sulphur. I discovered that the low-*z* elements H, C and N (which happen to also be the biogenic elements par excellence, on which life is built) can undergo a redox conversion that leads to an unexpected and new form of organic chemistry. At the same time, oxygen becomes oxidized – a process that introduces a good deal of semiconductor physics and opens a window of opportunity to study earthquakes from a perspective that had never before been explored.

## No quest for knowledge is more profound than the search for the origin of life

On a clear moonless night, we may look up to the sky and see countless stars. We know that some of the

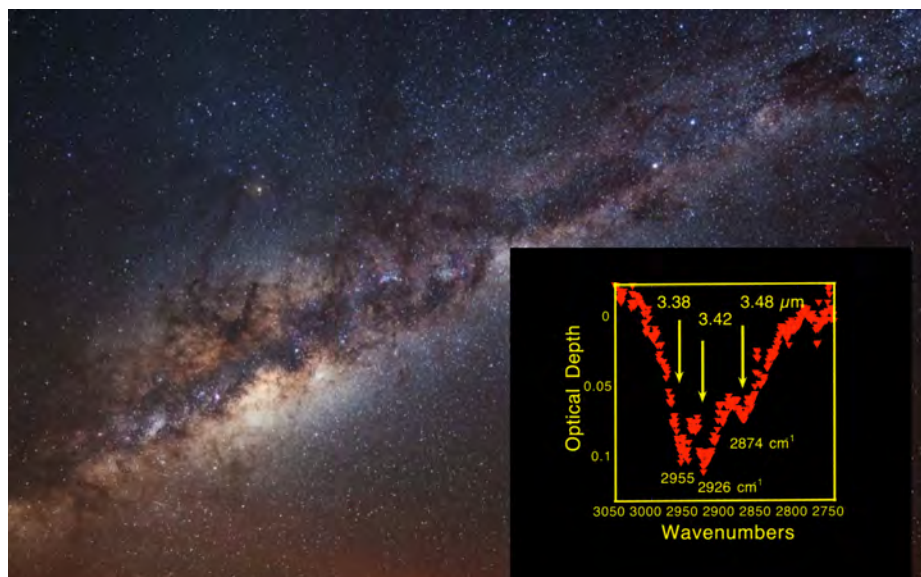


Figure 1: Milky Way with stars and dust clouds bearing the signs of delicate organics

speckles of light are far-away galaxies with their own countless stars. We see the Milky Way – a faintly glowing river of light marking the galactic plane, partly obscured by dark bands. These dark bands are dust clouds spreading through the interstellar space, composed of quadrillions of tiny mineral grains. These mineral grains are chockful of organics. Using a star embedded in a dust cloud as a lamp reveals the presence of aliphatic hydrocarbons, delicate organics that should not be able to survive in the harsh radiation environment of space, surely not for hundreds of millions of years. Yet, these organics are there, undeniably so, as Figure 1 shows – delicate but seemingly indestructible.

...and here on Earth we have life. When Earth formed some 4.5 billion

years ago, it was a lifeless orb of rocks and water, shrouded in a thick atmosphere. How could life have ever arisen here? How did it happen?

Over the past hundred years some of the world's best minds in chemistry, biochemistry, physical chemistry, chemical physics, and astrobiology have pored over this seemingly intractable question. Their goal? To find out how those complex multifunctional organic macromolecules might have formed that were needed for even the simplest life to start.

Tens of thousands of studies have been conducted, focusing on chemical reactions in the gas phase, in the liquid phase, at gas/liquid and gas/solid interfaces, even within the layers of soft clay minerals. None of them



produced the insight needed to understand how atoms of carbon, hydrogen, oxygen, nitrogen and sulphur could have combined on the barren early Earth to form the CHONS macromolecules necessary for life to start. The brutal truth is slowly sinking in that understanding the origin of life may still be quite a way off.

Something fundamentally new was needed, something different. This is where my work comes in.

At the beginning, I did not set out to study the origin of life. Far from this esoteric aspiration, I just wanted to find out how the common magmatic gases deep in the Earth – water, carbon dioxide, nitrogen and sulphur compounds – interact with the minerals that crystallize deep down.

I was in for a big surprise. To explain it, I have to become a bit technical.

When I started this work, it was well known and accepted in the science community that minerals, which gobble up magmatic gases such as water and carbon dioxide during crystallization but have no good place to put them in

their solid matrix, rip these molecules apart and incorporate them as hydroxyl and carboxy anion impurities. No one suspected, however, that this was not the whole story. My work led me to recognise that, at one point upon cooling, the protons in those hydroxyls and the carbon in the carboxy anions would steal electrons from their oxygens. As a result, the protons turn into hydrogen and carbon atoms turn into chemically reduced carbon – “organic” carbon – just like that, by a purely physical process.

The follow-on steps were even more baffling: the oxygens that had given away an electron changed their bonding character. They become highly deformable, allowing the chemically reduced carbon atoms to diffuse with relative ease through dense mineral structures, even when classical diffusion theory said that they should stay put. Indeed, I found the carbon atoms to be unexpectedly mobile, able to segregate to places, where they can ease the local stresses which they produce. Other carbon atoms do the same. Thus, carbon atoms come in close contact with each other and start tying carbon-carbon bonds.



Friedemann Freund, Professor

Hydrogen molecules join in, tying carbon-hydrogen bonds. As a result, organic protomolecules form in the most unlikely place in the world: inside the seemingly forbidding densest mineral structures.

## Organic synthesis in the solid state

As so often in science, when something is discovered which seems to be fundamentally new, a torrent of disapproval arises among specialists, many of whom said that this can't be true and trying to disprove the findings.



Fig. 2a: Magnesium Oxide

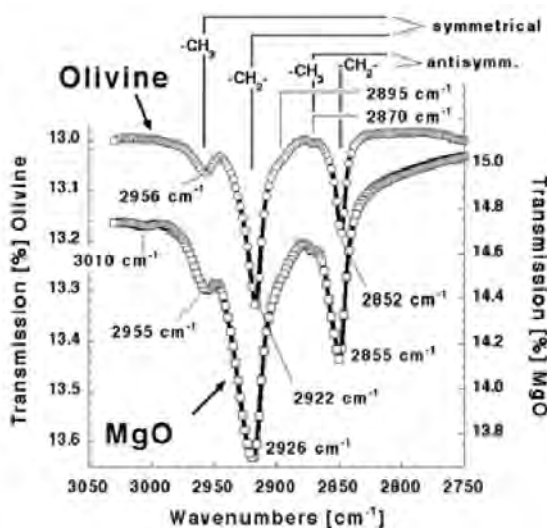


Fig. 2b: Olivine and MgO IR spectra



Fig. 2c: Upper Mantle Olivine

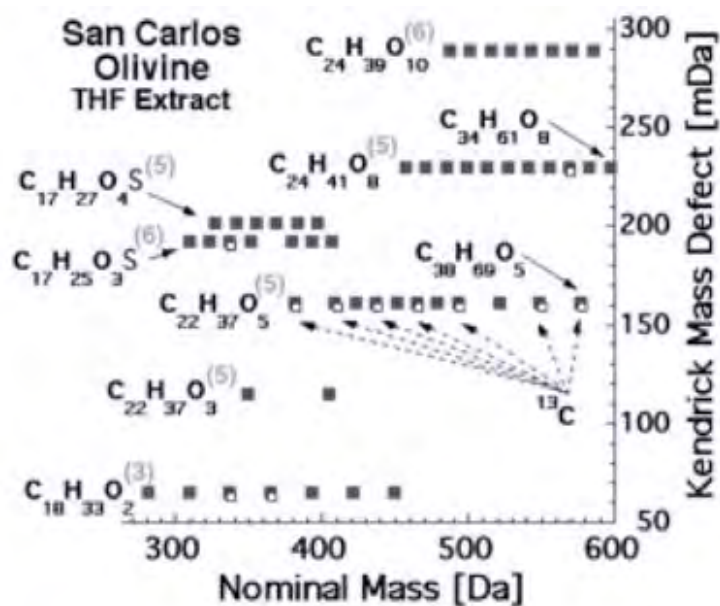


Figure 3a: Families of complex multifunctional organics released from crushed olivine single crystal grown deep in the Earth



Figure 3b: One of the few beaches of the world today, where olivine crystals still make up most of the sand

This happened to me with such vehemence that – for some time – I retreated from this field altogether to let the controversy die down.

But, of course, I could not let go. Often my thoughts returned to this nagging idea, whether this organic synthesis in the solid state may help us find an answer to humanity's most profound question: Where are we coming from and are we alone?

The tiny dust grains in the interstellar dust clouds consist mostly of olivine, a mineral that we also know on Earth. The dust grains are chockful of organics. If we take a gem-quality olivine crystal from Earth and shine an infrared beam through it, we see essentially the same organic signature as Figure 2 documents. This olivine crystal has grown in a searingly hot magma deep below. Yet, in its matrix, there are delicate organics. When we go into the laboratory and grow

magnesium oxide crystals from their more than 2600°C hot melt, we see the same spectroscopic signature.

When we take such crystals and crush them to expose those internal organics, we can extract whole families of CHONS with molecular weights up to 600 atomic masses as reported in Figure 3a. In addition, these CHONS are multifunctional macromolecules – just as needed.

When the Earth was young, olivine was abundantly available at the surface, exposed to rain and all other forms of erosion. On many beaches, the sand consisted of olivine as in this rare green beach in Hawaii depicted in Figure 3b. As the olivine crystals weathered away, they must have released their load of multifunctional macromolecular CHONS into the surface waters. Charles Darwin suggested in 1871 that life might have started in some “warm little ponds”.

Yes, Darwin was probably right, but if my work on organic synthesis in the solid state is on target, the organics in “warm little ponds” that crossed the barrier from lifeless to life were not delivered by meteorite impacts from outer space nor generated by electric discharges in Earth's atmosphere. They were most likely released by gentle weathering from the matrix of minerals such as olivine that had gobbled up water, carbon dioxide, nitrogen and sulphur at high temperatures deep in the rock column and created – upon cooling – precursors of amazing, probably life-giving CHONS.

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# The issues for the global recycling industry

Ranjit Baxi, Bureau of International Recycling (BIR) President and Founding President of the Global Recycling Foundation comments on the issues facing the global recycling industry and what plans the Global Recycling Foundation has for 2019, including the upcoming second annual Global Recycling Day on 18 March 2019

The outstanding success of Global Recycling Day 2018, with well over 13 million people across the world participating in the initiative, led to the launch of the Global Recycling Foundation by the Bureau of International Recycling (BIR) in October 2018.

The Foundation runs as an independent organisation to help promote and support the global recycling industry and highlight the importance of recycling in preserving the planet's future. We want to raise awareness that recycling practices need to be actioned by all in order to preserve the future of our planet. The Foundation will support joint ventures in education and fundraising, as well as the spotlight initiative that is Global Recycling Day itself.

The aim of Global Recycling Day is to celebrate the importance of recycling in preserving the planet's primary resources. Last year Global Recycling Day introduced the world to the Seventh Resource – the concept that the materials we recycle are as precious and as valuable as primary resources. It is safe to say that we sparked a global movement in 2018, with people young and old taking part in all four corners of the world; from Paris to the Maldives, London to Sydney, and Sao Paulo to Mongolia.

We need to educate more people around the world to the fact that recycling is no longer an option, but a necessity. Not only will the recycling industry contribute over \$400 billion to the world economy by 2025, but it plays a crucial role in resource preservation. Without it, our used plastic bottles, cardboard boxes, cars, clothes and fridges would end up on waste mountains or go to landfill, never to be used again.



*Ranjit Baxi, President, Bureau of International Recycling (BIR) and Founding President of the Global Recycling Foundation*

That is why one of our key taglines last year, one that will continue this year, is that we must think resource, not waste when it comes to the goods we use and reuse every day. It is only by reframing our thinking in this way, that we will come to treat what we discard with the respect it deserves, and it is why we call recyclables the Seventh Resource.

The second Global Recycling Day will take place on



18th March 2019, and is themed 'Recycling into the Future', focusing on the power of youth, education and innovation to work together towards a brighter future for the planet. Engaging youth and school children is vital in educating people on the crucial nature of global recycling, instilling best practice and habits from an early age. We want to encourage young people to take a more active role in both their own recycling and recycling in their communities, to showcase how important it is for their future. This also emphasises the need for better education on recycling and innovative ways to process recyclables in order for the Seventh Resource to become a valuable part of the protection of our planet.

To this end, we are asking people across the world to ask themselves seven key questions when it comes to their recycling habits. These are:

- How can I remove, reduce or recycle all single-use plastics (like drinking bottles, straws and plastic bags)?
- Do I and my family know and follow local recycling regulations?
- Does my household do its best to provide useable recyclable materials to our local collection teams (are they dry, clean and in the right collection bins)?
- How can I help the environment by mending, repairing and reusing as much as possible (do I really need everything to be new)?
- How can I help my family and my friends become recycling-aware shoppers?
- How can I recycle my used electronics when I no longer want them?



- How can I and my family reduce our individual waste-footprints by being conscious of packaging?

We are inviting people across the globe to share their recycling stories and innovations on 18th March 2019 and get together with their local communities, schools, families and friends to share best practices and embed good recycling habits into their everyday lives. More information can be found on our [website](#) at and on our social channels on [Twitter](#), [Facebook](#) and [Instagram](#). Join the conversation, and get involved by tagging your pictures, posts, and videos with #GlobalRecyclingDay and #GRDFuture. ■

To find out more about Global Recycling Day and to get involved contact [press@globalrecyclingfoundation.org](mailto:press@globalrecyclingfoundation.org)

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# Financing the low carbon economy: Heat networks

Charles Robson, Andrew Hirst and George Matthew from Womble Bond Dickinson tell us about meeting the UK's legally binding climate change targets in terms of financing the low carbon economy

In October 2018, the UK government launched its annual Green GB Week to highlight the opportunities clean growth offers the UK and raise understanding of how business and the public can contribute to tackling climate change. A key theme of the week was financing the low carbon economy and clean growth. Heat networks are expected to be at the forefront of this growth.

The government has a legally binding commitment to reduce greenhouse gas emissions by at least 80% of 1990 levels by 2050.<sup>1</sup> Heat currently accounts for around 18% of the UK's existing greenhouse gas emissions (by way of comparison, power is around 21% and transport is 24%). Meeting such challenging climate change targets will, therefore, require complete or near-complete decarbonisation of heat.

**“Launched by the Department for Business, Energy and Industrial Strategy (BEIS) on the 16th October 2018, HNIP is a major government investment project which will see £320 million of capital funding made available for the development of heat network projects.”**

Heat networks, as proven technologies for providing lower carbon heat to domestic and commercial customers, have the potential to play a key role in the long-term decarbonisation of heating, and local authorities can contribute significantly to their success in this emerging sector. Local authorities' involvement, particularly as a principal driver in the development stages of a project, can help realise the many benefits of heat networks, while also delivering jobs and growth.

Many local authorities may recognise the potential benefits of developing a heat network but lack the expertise and/or finance required to pursue such ambitious schemes. The government, therefore, is providing support to help facilitate the delivery of heat networks:



Charles Robson

## Heat Networks Delivery Unit (HNDU)

Established in 2013, the HNDU seeks to address the obstacles local authorities face when considering developing heat networks by providing grant funding and guidance on project development. Since its inception, HNDU has run seven funding rounds – awarding £17 million in total – and is currently running Round 8. Over 200 unique projects have so far been supported across 140 local authorities.

## Heat Networks Investment Project (HNIP)

Launched by the Department for Business, Energy and Industrial Strategy (BEIS) on the 16th October 2018, HNIP is a major government investment project which will see £320 million of capital funding made available for the development of heat network projects.





Andrew Hirst



George Matthew

The funding, made up of a combination of grants and loans, will be available from April 2019 and is offered as “gap funding”. Local authorities are encouraged to apply for the funding for a period of up to three years and it is hoped that the scheme will leverage around £1 billion of the private sector and other investment to support the commercialisation and construction of heat networks.

**“The government has a legally binding commitment to reduce greenhouse gas emissions by at least 80% of 1990 levels by 2050.<sup>1</sup> Heat currently accounts for around 18% of the UK’s existing greenhouse gas emissions (by way of comparison, power is around 21% and transport is 24%). Meeting such challenging climate change targets will, therefore, require complete or near-complete decarbonisation of heat.”**

### Published Guidance

BEIS have also commissioned various pieces of guidance relating to heat networks. As recently as August this year, the following were published with a view to guiding local authorities (and others) on various aspects of heat networks:

- [Heat networks: Procuring finance](#)
- [Financing heat networks in the UK: Guidebook](#)
- [Optimisation of heat networks: Issues for project sponsors to consider](#)

For further information on heat networks please get in touch with a member of our heat network team. ■

<sup>1</sup> Climate Change Act 2008

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# Delivering climate information for the regions

Climate Service Centre Germany (GERICS) has been selected as a co-host for the new World Climate Research Programme (WCRP) Coordination Office for Regional Activities (CORA)

At a time when the urgency with which we need to respond to the risks posed by climate change has perhaps never been more widely acknowledged<sup>1</sup>, there is also a pressing need to provide and deliver climate information for regions, so that well informed responses in the form of climate policies, risk assessments, and adaptation measures, can be developed.

The World Climate Research Programme<sup>2</sup> is the primary body for the international coordination of major research activities in relation to climate science with global and regional impacts. While the WCRPs work is primarily focused on delivering science results, the WCRP had recognised that there is a strong need to try and better connect the work that the WCRP does with the climate services community in particular, and with users of science-based climate information more generally<sup>3</sup>.

Given that the need for science-based climate information is most relevant at the regional level – where climate policies and adaptation measures will be enacted – in July 2017, the WCRP, following approval by the WCRP Joint Scientific Committee (JSC), invited applications to host a coordinator for WCRP regional activities, whose purpose would be to deliver on this identified need.

GERICS submitted a proposal to become the coordinator, and, following a competitive process, was selected to host the Coordination Office for Regional Activities (CORA), jointly, with the Bjerknes Centre for Climate Research (BCCR).

A Memorandum of Understanding (MoU) was signed between WCRP, GERICS and BCCR in July and August of 2018 and the Office officially opened on 1st September 2018, for a three-year implementation phase 2019-2021.

The office will identify opportunities, resources and partners to promote regional climate science in order to address key challenges and objectives in the context of the WCRP Strategic Plan 2019-2029. In addition, the office will assist in integrating and synergizing regional activities within WCRP in cooperation with all WCRP bodies, particularly with the Coordinated Regional Downscaling Experiment (CORDEX).

## Climate information for the regions

Reliable and robust regional climate information is a prerequisite for helping society adapt to climate change and variability. As a climate services organisation active in various regions around the world, GERICS is only too well aware that some regions of the world are better catered for in this

regard than others. GERICS staff can bring decade's long experience to bear in resolving global and process level science questions, to deliver regional climate information. As such, the regional coordinator role represents a wonderful opportunity to further GERICS' long-standing vision to see the worldwide provision of regional climate information at a range of timescales from observations of the present day, through seasonal and decadal predictions, to multi-decadal climate projections. The realisation of this vision requires, among other things, key breakthroughs in climate science. Being able to bring the various WCRP programmes together with the numerous complementary scientific communities to deliver this science is a task that GERICS is ideally placed to perform, together with colleagues from the BCCR.

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**“The regional coordinator role represents a wonderful opportunity to further GERICS' long-standing vision to see the worldwide provision of regional climate information at a range of timescales.”**

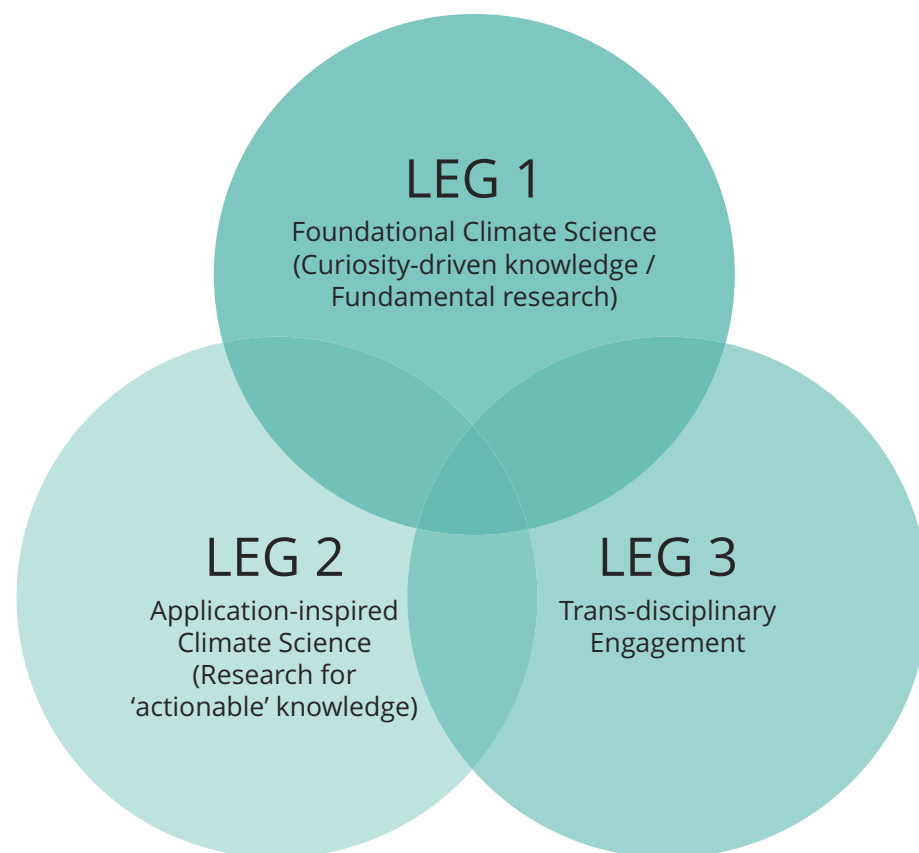
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GERICS, as a climate service center, can only perform its role effectively by having a strong connection to foundational science, together with an understanding of what users actually need to answer policy questions. As such, GERICS' work is, almost by

definition, trans-disciplinary in nature. These three elements that characterise GERICS' work, correspond very closely to those of the WCRP regional climate initiative (figure 1), and as such, augurs well for the development of new activities that can quickly start to make a difference to the work of the WCRP in delivering climate information for regions.

**“The office will identify opportunities, resources and partners to promote regional climate science in order to address key challenges and objectives in the context of the WCRP Strategic Plan 2019-2029.”**

Commenting on the establishment of the joint office, Professor Daniela Jacob, Director of GERICS, stated, “Reliable and robust regional climate information is essential for informing appropriate responses to the threat posed by climate change. GERICS' expertise at the regional level is complemented beautifully by the wide-ranging expertise at the global level that the Bjerknes Centre possess, which means that as a partnership, we offer a knowledge base that I find difficult to imagine being better. As such, the joint office promises to strongly contribute to the aims and objectives of WCRP and we are really excited about what the future holds for regional activities, both from a science point of view, and also in terms of help-



*Figure 1: The three 'legs' that form the basis of the WCRP's work at the regional level. Source: WCRP*

ing to make sure that science is applied to solving real-world problems.”

To get in contact with the WCRP Coordination Office for Regional Activities (CORA), please contact Paul Bowyer, Senior Staff Scientist at GERICS, or at BCCR Ragnhild Stolt-Nielsen, Head of Administration BCCR.

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- 2 <https://www.wcrp-climate.org/>
- 3 [https://www.wcrp-climate.org/WCRPpublications/2016/WCRP\\_Report\\_23\\_2016\\_Regional\\_Scoping.pdf](https://www.wcrp-climate.org/WCRPpublications/2016/WCRP_Report_23_2016_Regional_Scoping.pdf)



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# Global efforts to fight hunger and feed the planet in a sustainable way

Commissioner Phil Hogan shares his remarks on World Food Day 2018 at the Civil Dialogue Group Discussion – Global Food Security, Sustainable Development and Relations with Africa on 16th October 2018, where he charts global efforts to fight hunger and feed the planet in a sustainable way

World Food Day is an important opportunity to take stock of where we stand in our global efforts to fight hunger and feed the planet in a sustainable way. This challenge is huge, but we are finding more and more solutions. This is truly one of those situations where you can say we are all in the same boat.

Fighting hunger and fighting climate change requires everyone to do their part, therefore we cannot say to our counterparts: “your end of the boat is sinking”.

If we take a step back from the bureaucracy and politics surrounding it, food, in essence, represents both bodily and cultural sustenance, and the struggle to eliminate hunger is ultimately about saving individual human lives from being ended prematurely by a lack of nutrition.

In this sense, World Food Day is the right moment to recall the UN Sustainable Development Goals, and particularly Goal number 2: ‘Zero Hunger’. Those two short words encompass a bold, but necessary ambition.

During the reference period covered by the previous Millennium Development Goals, from 1990 to 2015, the percentage of the world’s population suffering from undernutrition was almost halved, from close to 20% to just above 10% – and this was achieved while the world’s population grew by 1 billion.

But recent data provided by FAO show an alarming trend. The number of people suffering from undernourishment is increasing again. The message is clear: we need to step up our efforts. The director of the Brussels office of FAO will give us further details on this. Europe is not immune to food insecurity: mass-

scale hunger took place on our continent within living memory.

We established the CAP to fight food insecurity in post-war Europe, and it has served our continent well for the past 60 years. Today, the policy has a far more global outlook and it is more closely aligned to other important EU policies, such as development and regional cooperation.

In this regard, I think it is fair to say that the CAP has come a long way. Today, the policy balances the interests and needs of a complex matrix of farmers and consumers in Europe, as well as food growers, consumers and citizens concerned about the environment and the welfare of animals, and last but not least our trading partners abroad, including developing countries.

It is a well-known fact that the European agricultural sector is one of the world’s leading producers of food, and the EU is the world’s top agricultural exporter and importer. We have extremely favourable trading conditions for countries across the developing world.

We are, in particular, the world’s largest importer of agricultural products from Least Developed Countries, to whom the EU gives duty-free and quota-free access, while granting unilateral concessions to developing countries in general.

Our trade agreements for development, the Economic Partnership Agreements, are calibrated to allow sufficient margin of manoeuvre for partner countries to protect their sensitive agricultural products, either by excluding them entirely or by allowing robust

safeguards that can be used to guard against sudden increases in imports.

The EU also promotes food security and food quality, both at home and abroad. Food security, ultimately, means more than just ingesting calories, but rather ready access to a healthy variety of quality nutrients.

In terms of sustainability, the environmental safeguards built into EU food and farming policy are already robust, and are in the process of being strengthened further in our legislative proposal for the future CAP.

Already today, 30% of the direct payments to European food producers (whose incomes still lag far behind the average of other economic sectors) and nearly half of the EU budget for rural development are spent on measures benefiting the environment or fighting climate change.

The EU is also active abroad and lends vigorous support to food security and responsible investment in sustainable agriculture, particularly in Africa, where our focus is on creating decent rural employment, ensuring that farming remains a viable, even attractive way of life for the huge aspiring generation of young Africans.

To this end, the EU promotes rural and agricultural development, for instance by supporting investment in African farms and agri-business, programmes to increase compliance with sanitary and phytosanitary standards, vocational training.

And the African Union strategy for Geographical Indications. EU-funded research and innovation programmes also benefit developing countries, notably via participation in the Horizon 2020 Programme.

As you have no doubt all noticed from Commission President Juncker's State of the Union address, the EU's relationship with Africa will take on even more importance in the coming years. The Communication on the Alliance with Africa calls for a paradigm shift, from framing our southern neighbour as a recipient of aid to working together as equal partners in mutually beneficial development.

Agriculture is already following up on this commitment. An important and highly visible initiative is the Task Force for Rural Africa, which I launched in May 2018. This group of African and European experts has already met several times in Brussels and once in Kigali, Rwanda, and serves as a forum to exchange and transfer insights, identify key trends, find new solutions, as well as map policies what work well and should be reinforced.

I wanted to emphasise a key message that this day, World Food Day, symbolises. The challenges ahead are great and global in nature, therefore our best hope of tackling them is to do so multilaterally.

As I mentioned earlier, we're all in this 'boat' together. So, if we want to continue sailing smoothly we must also work together. Ensuring that in 2030 there really is "zero hunger" on the planet: this is the challenge that World Food Day reminds us of every year.

The family of international organisations involved in the politics and economics of food, such as the FAO, the OECD, and indeed the EU, are the best placed global players to assume a leading role in future-proofing the world food system. To master this challenge, we must stand and work together. Thank you. ■

*This article is based remarks given by Phil Hogan, Commissioner for Agriculture & Rural Development on [World Food Day 2018](#), delivered at Civil Dialogue Group Discussion – "Global Food Security, Sustainable Development and Relations with Africa."*

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# The role of the UK food manufacturing industry in global food science and innovation

Tim Foster, Professor of Food Structure at the University of Nottingham sheds lights on the role of the UK food manufacturing industry in global food science and innovation

In January 2009, the RSC/ICHEME report *Food: The Vital Ingredient* was launched at Portcullis House and reported on the need for fundamental research within virtual centres of excellence, in order to keep the UK food manufacturing industry at the forefront of global food science and innovation.

The importance of such is evidenced in the fact that the food and drink manufacturing industry is the biggest manufacturing sector in the UK – bigger than the automotive and aerospace industries combined. The food supply chain employs almost 4 million people and generates £112 billion of value to the UK economy each year and contributes £28.8 billion to the economy.

Three centres were funded in 2013 ('EPSRC Centre for Innovative Manufacturing in Food (CIM)', the 'Centre for Sustainable Energy Use in Food Chains' and the 'National Centre of Excellence in Food Engineering'), which collectively have developed 80 researchers (future research leaders), enabled a national network of leading academics to be developed and which have acquired £17 million in additional funding. The funding for these three centres finishes in 2019.

Here a focus will be on the success of

the EPSRC CIM, which is led by the University of Nottingham's Biomaterials group and also involves the Centre for Formulation Engineering at the University of Birmingham and Loughborough University's Centre for Sustainable Manufacturing and Recycling Technologies (SMART). It was initially proposed to EPSRC by PepsiCo International, had an additional 13 letters of industrial support and received £5.6 million from EPSRC and £1.1 million of support from the participating universities.

Since its beginning at the end of 2013 to date, it has interacted with over 120 companies, either attending annual research conferences (which have boasted esteemed international speakers), workshops probing new directions such as additive manufacturing (3D printing of food) and food waste valorisation, or secondments of industry staff into the CIM or CIM researchers practicing knowledge exchange in their interactions with industry. It has been involved in the development of the KTN/FDF 'Pre-competitive vision for the UK's Food and Drink Industries' (Dec 2013), and as a result of two CIM run workshops in co-creating funding opportunities of the future, to the IUK/KTN's 'Food Sector R&D Need & Alignment with the 2017 Government Industrial Strategy' (Feb 2018).

Indeed, the outputs of the workshops were shared back in Portcullis House in December 2017 at the Parliamentary and Scientific Committee & All-Party Parliamentary Group for Food and Drink Manufacturing discussion meeting, where a vision for unifying the three centres funded in 2013 was unveiled to make the UK the most efficient converter of biomass to deliver safe food for a healthy nation with the lowest environmental impact.

The scientific barriers to be addressed are:

1. To develop novel processing routes capable of valorising new sources of biomass (including waste re-use) and manufacturing healthy products tailored to the needs of consumers (for example, customisation for nutritional requirements) and;
2. To develop efficient systems that integrate supply chains with manufacturing requiring fewer resources (for example, through the use of smart monitoring).

These would support and play into the five areas identified by the KTN's Food Sector Strategy group (18 companies, six research organisations/institutions, two funding bodies and 10 universities), where there is an excellent UK research and industrial capability and global market potential:



Researchers, academics and industrialists enjoying the 4th CIM International Conference in March 2018



1. Reducing food energy density;
2. Side-stream valorisation;
3. Sustainable new food sources for nutritional foods;
4. Flexible and scalable manufacturing and;
5. Digital manufacturing.

The CIM has delivered against its initial targets, which have been the forerunner to the desired pre-competitive areas and have published over 90 peer-reviewed publications and five patents while developing researcher and academic careers, with two promotions to Professor, three researchers given permanent academic tenure, and post-doctoral and PhD researchers progressing into attractive industry roles. In total, the CIM has developed the careers of over 60 researchers. In doing so it has been used as an umbrella to stimulate further work, leading to an additional £7.5 million of research funding.

Notable additional projects funded/delivered in the timeframe of the CIM are:

- 'Transforming wet perishable food waste streams for high value human consumption' (TS/K003984/1), with Nottingham working with the University of York and 10 food companies valorising fibre from citrus waste, fine-milled pea vive, BSG aleurone protein and protein separation from out of specification potatoes;
- 'NewTriton: ReNEWable, sustainable nuTRITION' (2016-2019) funded by Newton-Bhabha (TP/P003826/1), seeing Nottingham working with PepsiCo, Siddarth Starch and the Indian Institute for Food Processing Technology on potato, vegetable, oat, grape, pomegranate and black gram waste;
- 'Whole systems understanding of unavoidable food supply chain wastes for re-nutrition' (2016-2018) funded by EPSRC (EP/P008771/1) with Loughborough, Nottingham and the University of York working on citrus and pea waste streams, developing waste flow modelling and environmental analysis through LCA to enable socio-techno-economic evaluation through cost-benefit analysis, risk analysis and systemic

barriers exploring the gap between concept and final implementation and;

- 'Formulation for 3D printing: Creating a plug and play platform for a disruptive UK industry' (EP/N024818/1) linking Birmingham with the Institute of Advanced Manufacturing at Nottingham and spanning the food and pharmaceutical industries.

This increased activity in the area of food research has also prompted institutional investment at Nottingham (£20 million) and Birmingham (£12 million), with investments in Future Foods Beacon of Excellence, Food Process Engineering and Healthy Food Manufacturing.

The virtual centre of the future, serving a thriving research and innovation-based community, both industrial and academic, is still needed to build on the foundation laid by the CIM to provide knowledge-based solutions relevant to all businesses in the sector from micro-SMEs to national and multinational providers.

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# World-class research to address the challenge of providing nutritious and palatable food

David Salt, Director of the Future Food Beacon at the University of Nottingham explains the world-class research talking place to address the challenge of providing nutritious and palatable food

The Future Food Beacon is one of six Beacons of Excellence invested in by the University of Nottingham to tackle significant global challenges. The Future Food Beacon has expertise across the food system, from soil, molecules, and meals to health, cultures and histories. The mission of the Future Food Beacon is to deliver world-class research to help address the challenge of providing sufficient quantities of nutritious and palatable food to a growing world population within a changing environment.

The Future Food Beacon brings together the power of genome-enabled plant and animal sciences with cutting-edge nutritional science, food processing, and manufacturing and digital technologies, informed by an understanding of the economic, legal, social and ethical issues that underpin and shape food systems.

The Future Food Beacon is targeting six of the major challenges to ensure global food security:

- Soil challenges: Reducing soil erosion and improving soil fertility;
- Water challenges: Improving water conservation through crop resilience and irrigation systems;

- Production challenges: Maximising yields, stabilising yields in the face of climate uncertainty, minimising waste and improving access;
- Nutrition challenges: Improving the nutrient density of staple and processed foods;
- Protein challenge: Providing alternative and palatable proteins for human and animal diets and;
- Climate challenges: Developing robust food systems that are able to cope with climate uncertainty.

Understanding food as a global challenge means developing relationships and networks worldwide. The Future Food Beacon is concentrated on developing research networks, capacity building, and skills sharing across the world but particularly in the global south. To that end, we have developed a number of research projects that allow us to share our research skills and knowledge with food producers both on and off the farm, nationally and internationally, and further develop capacity through research training programmes.

The Future Food Beacon is developing partnerships with key players in the cocoa industry, building relationships

with FEDECACAO and Casa Luker in Columbia, and the Cocoa Research Centre in Trinidad.

We are working with an SME in Nottingham, Luisa's Artisan Chocolates, to connect commercial chocolate makers with cocoa growers in Columbia. This project aims to develop on-farm processes to optimise cocoa fermentation for improved chocolate flavour and quality. Using hand-held DNA sequencing equipment (the innovative MinION developed by Oxford Nanopore), researchers and farmers will measure the microbes fermenting the cocoa beans, in order to better understand the fermentation process. Once this process is understood, researchers can work with farmers to manipulate fermentation in order to achieve the best possible flavour for the chocolate maker, and ultimately, the consumer.

The Future Food Beacon is working with Professor Martin Broadley, a Professor of Plant Science at the University of Nottingham (UoN). Prof Broadley was the recipient of a £4.4 million Bill and Melinda Gates Foundation grant for the GeoNutrition project. Working with project partners including UoN, LUANAR, Addis Ababa University, governments in Malawi and Ethiopia, the International Maize and Wheat Improvement Centre, the International

Crops Research Institute for the Semi-Arid Tropics, the World Agroforestry Centre, Rothamsted Research, London School of Hygiene and Tropical Medicine, and the British Geological Survey, Professor Broadley aims to help alleviate the problem of hidden hunger in Malawi.

Mapping the country through crop and soil samples from some 2000 farms, the project will identify nutrient deficiencies in the soil, and thus the crops. Such deficiencies put children in particular at risk of infection and developmental problems. The project is interdisciplinary, using research expertise from people such as Dr Kate Millar of the Centre for Applied Bioethics and the Future Food Beacon, to examine the ethical and socio-economic issues of adding minerals to the food chain via fertilisers or enriched food. The knowledge gained in Malawi will be used to inform geospatial mapping in Ethiopia and has the potential to influence public health interventions across the region.

Collaborations with colleagues at the Senegalese Institute for Agricultural Research (Institut Sénégalais de Recherches Agricoles) and colleagues in France has led to a new project that will identify varieties of pearl millet with improved root architecture and anatomical traits designed to improve resilience to drought stress. Pearl millet is a staple food of approximately 100 million people, and 90% of it is grown by smallholder farmers. Drought in the Sahel, a region bordering the southern edge of the Sahara in Africa, is a major hindrance to pearl millet production. As climate change brings further unpredictable weather patterns, selecting new varieties of pearl millet is imperative.

The team will collect root samples during field trials in Senegal, which will

then be shipped back to a specialist facility at the University of Nottingham. Using a new anatomical imaging technique developed with U.S. colleagues at Penn State (termed 'anatomics'), researchers will rapidly screen varieties for desirable root anatomical traits from a diverse collection of pearl millet lines. The ultimate goals of this project are to pinpoint the key genes that control desirable traits, share expertise, resources and data with research partners, breeders, and smallholder farmers to advance breeding programmes, and develop more resilient crops. This will have a real impact on the everyday lives of people living in the Sahel, and in other communities where pearl millet is grown as a staple crop.

The Future Food Beacon is focused on building strategic links in China. Two recent successful grants, funded by Innovate UK, focus on the challenges faced by Chinese agriculture, building our specialist capacity in the country, and further developing our networks. *Research and Developing of Alternative Feeding Antibiotic Products from Herbs* will explore the possibilities of traditional Chinese herbal and botanic medicine in the effective rearing of livestock. Led by Prof Serafim Bakalis in Engineering, the project concentrates on reducing and/or preventing infectious diseases in pigs and poultry, in a cost-effective and more efficient way. This project brings together Micolta, a Chinese firm specialising in traditional Chinese medicine; KPAD, a food process analysis and design consultancy; the University of Nottingham; and Hunan Agricultural University. The project aims to decrease the use of antibiotics and hormones in livestock production, by finding alternative plant sources.

*FARM WATCH: Fight Antibiotic Resistance with Machine Learning and a Wide Array of Sensing Technologies* is led by Dr

Tania Dottorini, of the School of Veterinary Medicine and Science at UoN. The rapid increase in poultry production to meet growing demand in China has resulted in the extensive use of antibiotics. This has been accompanied by increased antibiotic resistance (ABR) and zoonotic transfer to humans via direct contact, environmental contamination, and food consumption. Effective and rapid diagnosis of bacterial infection in chickens could decrease the need for antibiotics.

FARM WATCH will identify and validate new diagnostic biomarkers for use in the Chinese chicken farming industry. Biomarkers will predict and detect a bacterial infection, the resurgence of ABR, and zoonotic transfer to humans. Using machine learning and cloud computing, large-scale data collection and statistical modelling will allow a thorough understanding of epidemiological pathways of infection, which will allow the development of biomarkers. This will ultimately lead to improved poultry production practices.



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# Biomass sidestreams: Promising feedstock to achieve a sustainable bioeconomy

Hartmut Welck, Project Manager at Steinbeis 2i GmbH puts across the point that biomass sidestreams offer a high potential to achieve the goal of a sustainable bioeconomy

A major challenge for the future is the high competition on feedstock for different applications (like for energy and/or material usages) with implications on rising prices for biomass sources, rising biomass harvestings and rising transporting distances and costs. The availability of raw materials and the efficiency of their use will, therefore, become a new competitive advantage. Therefore, biomass sidestreams offer high potential in terms of a multi-cascading usage and also in respect to achieving close-loop-systems.

The biobased economy is seen by many as a future base for a sustainable society and economy. New innovative techniques, partnerships, businesses and policies are being developed, replacing fossil-based fuels and materials with renewable materials. Biomass, as a renewable and abundant resource, has many direct and indirect applications for food, feed, fuels, fertilizers, chemicals and materials. In a sustainable bioeconomy, wastes and industrial side streams will play an even more significant role as raw materials. <sup>(1)</sup>

The EC H2020 funded project AGRIFOR-VALOR ([www.agriforvalor.eu](http://www.agriforvalor.eu)) focusses on the valorisation potential of biomass sidestreams <sup>(2)</sup> by facilitating innovation partnership networks, aligning multi-actors from primary sector (agriculture and forestry) with the business and research community piloted in three hubs, Hungary, Ireland and Andalusia (Spain).

The EC Directive 2008/98 sets the basic waste management concepts and definitions, such as definitions of waste, recycling and recovery. It explains

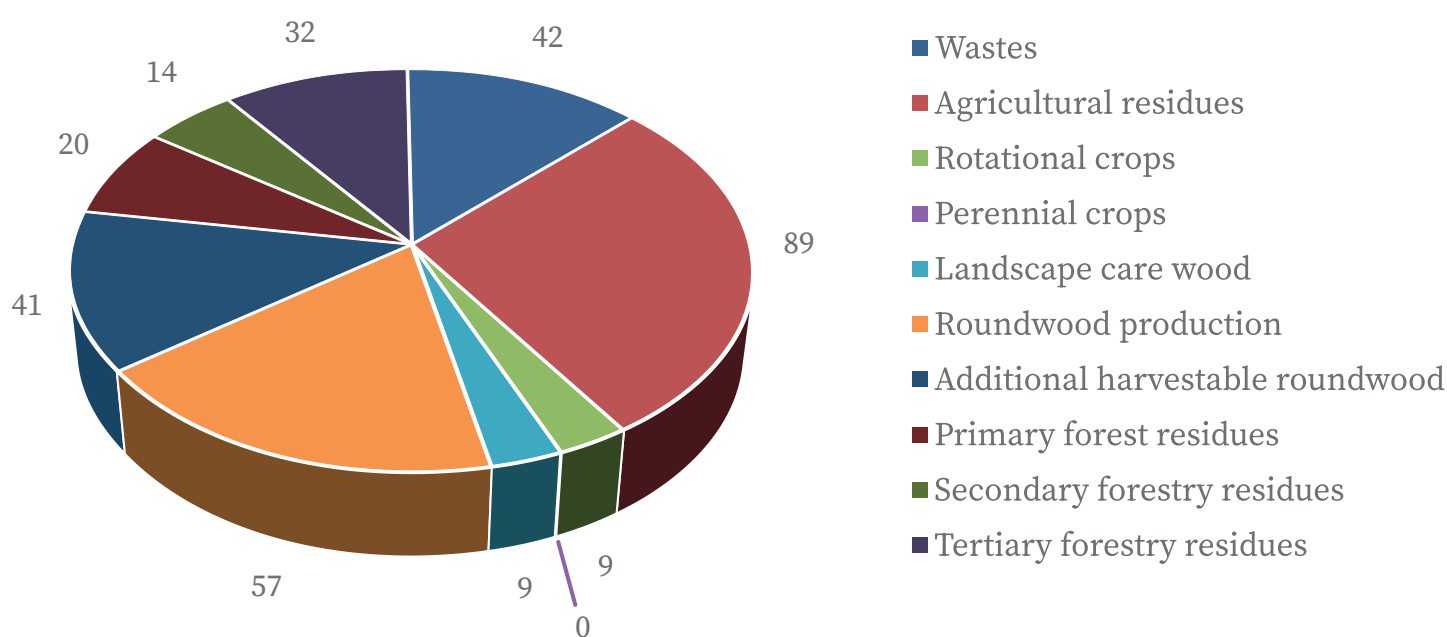


Figure 1: Available agricultural and forestry biomass in Europe (source: Elbersen et al. 2012)

when waste ceases to be waste and becomes a secondary raw material and how to distinguish between waste, by-products and residues. <sup>(3)</sup>

Sidestreams role in achieving a sustainable bioeconomy is important to broaden the feedstock base without increased land usage and added to this, they are non-food competitive. <sup>(4)</sup> In addition, circular concepts can be successfully applied to biobased

production chain in terms of “waste” valorisation, as each step in the supply chain of biobased products may provide sidestreams with different characteristics, which can be valorised in various ways. <sup>(5)</sup>

For Europe (EU-27), available biomass sidestreams were estimated to be **314 MTOE**, of which estimated agricultural residues (**89 MTOE**) and (primary and secondary) forestry residues (**34 MTOE**)

are the main sources as shown in figure 1. <sup>(6)</sup>

In figure 2, a rough estimation of agricultural and forest-based biomass sidestreams (kton) available within the AGRIFORVALOR Innovation Design Hubs is given.

From figure 2, it follows that the different hubs each have their own specific palette of available biomass

Biomass sidestream	Innovation Design Hub		
	Andalusia, Spain	Ireland	Hungary
Olive pruning	2,524		
Olive leaves	345		
Olive pits	552		
Olive pulp	3,011		
Two-phase olive waste	3,544		
Straw	1,901	421	7,000
Grass		1,700	0
Corn residues			14,000
Sunflower residues			1,000
Sugar beet industry residues			33,000
Fruit tree pruning			2,000
Apple pomace		5	
Spent mushroom substrate		240	12,000
Dairy sidestreams		200	60,000
Slaughterhouse waste	100	214	
Paunch waste		100	
Pig slurry	1,477	1,423	
Cattle manure	1,371	33,983	
Chicken manure	350	140	
Forest harvest residues			1,500
Panel industry residues		45	
Post-consumer wood residues		90	
Saw mill residues – bark		33	
Saw mill residues – sawdust		45	

Figure 2: Estimation of biomass sidestreams in the three hubs

sidestreams. In Andalusia, there is a huge availability of residues from the olive groves and processing industry. Ireland has a large surplus and sidestreams of grass and manure from livestock, while in Hungary there are a lot of dairy sidestreams, and crop residues, including straw and residues of sugar beet and corn production. Depending on the type of biomass sidestreams, different techniques to valorise the biomass sidestreams can be stimulated regionally.

The analysis of valorisation techniques of biomass sidestreams in the hubs have shown that for agricultural related biomass sidestreams, digestion, extraction, fermentation, combustion and pyrolysis seem promising techniques resulting in building blocks, intermediates and end products for use in the food, (fine) chemical, functional materials and fuel sector.

For forestry related biomass sidestreams, extraction, combustion, pyrolysis, chipping and pelletising are important techniques found to valorise woody sidestreams into marketable products, such as heat, electrical power, fertilizer, biochar, bio-oil and syngas.

Agricultural biomass sidestreams are mainly valorised to food applications, probably due to its calorific value in combination with the cost-effectiveness of the techniques and biomass side-streams. <sup>(7)</sup>

As concerns good practice cases, there are promising examples, such as olive biomass sidestream valorised as functional foods, food supplements and active pharmaceutical ingredients (Natac),<sup>(8)</sup> sawmill sidestreams valorised

as wood pellets (Laois Sawmills) <sup>(9)</sup> plus meadow grass valorised as bioplastic, fine chemicals and natural fertilizer (BioWert). <sup>(10)</sup>

An internet application presents valorisation techniques and good practice cases: the [Sidestream Value Tool](#). This digital interactive and dynamic tool enables the sharing of information, connecting multi-actors and identifying exploitation topics and new business models. It also allows registered users to add more sidestream profiles.

## Conclusion

Biomass sidestreams have a massive potential to contribute to Europe's policy on renewable energy and biobased economy. Many innovations are ongoing. This comprises research as well as building up experiences at pilot scale, market implementation and business development. A sustainable circular biobased future is coming closer, but still, a giant step has to be taken in this transition from a fossil-based economy to a sustainable renewable and biobased economy.

The transition will be stepwise, building on recently developed techniques and working on innovations through cross-sectoral and interdisciplinary research and development activities. Besides the local availability of biomass sidestreams, the local availability of knowledge, experience, culture and policy context will determine which valorisation techniques are most suited. The ability to learn, cooperate and implement locally is very important for success. Connecting to multi-actor networks, including biomass producers, science, education, and the finance and business sector, is key for access to knowledge and business solutions,

and for achieving a sustainable bio-economy in the future.

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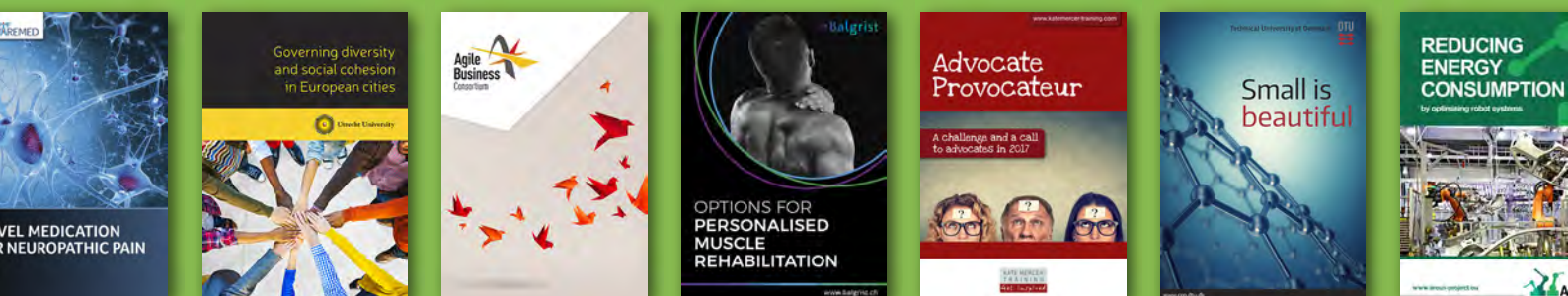
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# The re-emergence of potato late blight: A major reason for pesticide use in arable crops

Didier Andrivon, Research Director (Senior Scientist) at INRA provides an absorbing account of the disease, potato late blight and its re-emergence and explains why it is a major reason for pesticide use in arable crops

The first outbreak of late blight in Europe was spotted in Belgium in 1844 (Bourke, 1964) – that is, 175 years ago. The pathogen became epidemic the next year, and caused generalised famine, with outstanding consequences: almost 1.5 million people died in Ireland alone, another 2 million emigrated to the New World within a span of five years, and the food shortages everywhere in Europe scoured the onset of the 1848 revolutionary movements that shook the continent.

**“Oddly enough, late blight is not a disease of the past. Despite almost two centuries of scientific and operational research, the cost of late blight (losses to the pathogen and cost of control measures) exceeds €1 billion a year in Europe alone.”**

This catastrophic event had also very far-ranging scientific consequences. The quest for the causes of the disease led to the formulation of the ‘germ theory’ – that is, the realisation that microbes could be pathogenic. The hygiene consequences of this theory continue to fuel our vision of microbial diseases. On the other hand, the observation that fields close to zinc and copper factories widely escaped the disease formed the basis of the discovery of the first industrial



pesticides, namely the Bordeaux mixture, which are still in widespread use today in both conventional and organic cropping systems.

Oddly enough, late blight is not a disease of the past. Despite almost two centuries of scientific and operational research, the cost of late blight (losses to the pathogen and cost of control measures) exceeds €1 billion a year in Europe alone (Haverkort et al., 2008). Late blight remains a major reason for pesticide use in arable crops – with up to 20 sprays a year in severe blight pressure years (those with wet and cool springs and summers), according to [Euroblight survey data](#). The worldwide expansion of the potato and increasing

international trade make late blight a global problem.

## **Why late blight has not gone away**

Why has late blight not gone away, and why is it rather expanding? In other words, why is it now regarded as a re-emerging disease? Several factors are involved (Fry et al., 2015).

### **1. An expanding range and severity**

The epidemiological networks, such as ProMED-Plant, now spot the disease in areas where it was rare or absent before (in particular in Asia, but also in many parts of sub-Saharan Africa), and also highlight a higher prevalence in

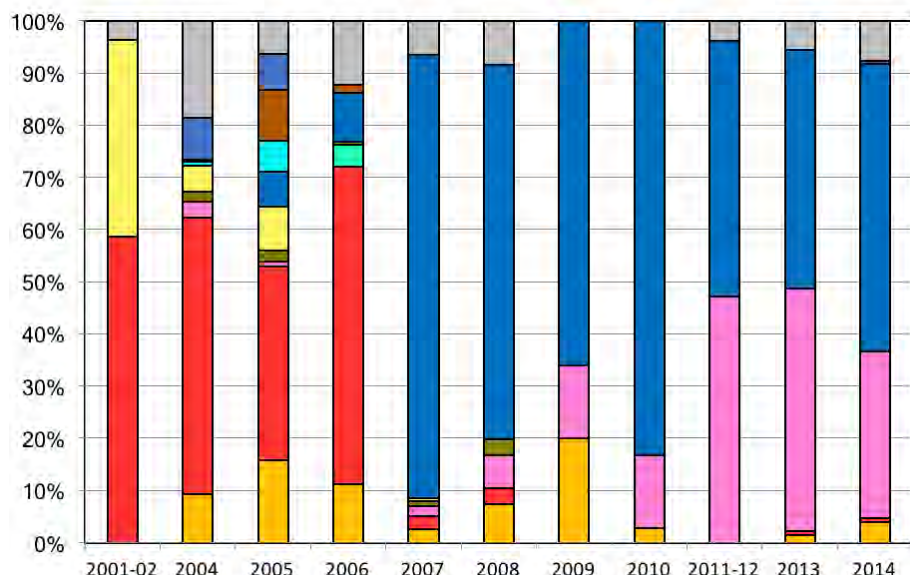


Image: © Euroblight

*Rapid population changes in European populations of the late blight pathogen, *Phytophthora infestans*. Each colour represents a clonal lineage, i.e. a set of closely related genotypes. As shown by the graph, very abrupt changes in frequency can occur within a very short time span, making control strategies (choice of cultivars, spraying rates or intervals) all the more difficult to adjust.*

‘historical’ areas of its distribution. The reinforcement of international trade favours rapid migrations, within the European continent, as well as between continents, of new, aggressive pathogen genotypes (e.g. Fry et al., 1992; Cooke et al., 2008; Njoroge et al., 2016).

## 2. Rapid changes in population composition

The late blight pathogen, *Phytophthora infestans*, is remarkably diverse. This might well be a consequence of its large genome, with rapid duplication of genes (Haas et al., 2009). As a consequence, the genetic structure of local pathogen populations, and hence their pathological characteristics, change utterly rapidly, and in unpredictable ways (see figure).

## 3. Modifications of their epidemic characteristics

Climate change reinforces the concerns about the dangers for crop production caused by late blight, with earlier outbreaks and greater expansion of susceptible crops due to temperature increases (Lehsten et al., 2017; Hansen

et al., 2015). For instance, the first late blight symptoms are now seen in potato crops about a month earlier than in the 1970s in Scandinavia.

## 4. Impacts of regulations and crop protection practices

Recent moves towards a general reduction in pesticide use has led to a marked withdrawal of large-spectrum fungicides. The current restrictions on pesticide use and approval, under the terms of EU Directive 2009/128/EC on the sustainable use of pesticides, and the slow innovation rate for alternatives on the market, make these concerns very acute.

## 5. Gaps in the arsenal of tools that can be integrated into sustainable IPM strategies

Integrated Pest Management (IPM) strategies rely on combinations of control means – resistant cultivars, biocontrol solutions, prophylaxy (seed certification, removal of refuse piles and leftovers from previous crops), and targeted application of pesticides using adequate decision support systems designed to predict epidemic

risk periods. We currently lack key information about some of these means (for instance, the optimal conditions to efficiently use plant defense stimulators), and we also need to adjust most of them (cultivar choice, DSSs) to local pathogen populations.

There is still, therefore, a considerable margin for improvement, and intense research efforts to make before late blight can, finally, become a disease of the past.

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# European Precision Livestock Farming (PLF) for animal welfare and health

Daniel Berckmans and Tomas Norton at M3-BIORES, Catholic University of Leuven detail how European Precision Livestock Farming (PLF) benefits animal welfare and health

Animal welfare is important from an ethical viewpoint but there are more reasons why its importance can hardly be overestimated. One of the main problems coming to us is the issue of antimicrobial resistance (AMR). It is the ability of microorganisms (like bacteria, viruses, and some parasites) to stop an antimicrobial (such as antibiotics, antivirals and antimalarials) from working against it. As a result, standard treatments and medication become ineffective, infections persist and can spread. In low estimates, the World Health Organization fears 10 million fatalities in 2050 due to AMR. Since most of the diseases for humans are coming from animals, it is clear that we have to monitor our livestock for our own health. This is reason enough to develop and proceed with implementing as far as we can, the automated continuous monitoring of livestock by technology. Other good reasons are the significant influence of the livestock sector on air quality, global climate, soil and water quality and other environmental concerns like gaseous ammonia (NH<sub>3</sub>) in the atmosphere, of which 50% derives from the livestock sector.

To fulfil the worldwide increasing demand for animal products (meat, eggs, milk) and to create at the same time a more sustainable livestock sector, we need to produce more animal products with less feed input. In other words, we need to increase



efficiency. For humans, the literature has described since 1956 that every physical or mental performance requires a certain level of mental focus or mental stress. A company or institute without stress will not perform due to a lack of focus, of engagement and of the so-called good stress or eustress of the employees.

Stress can be very positive to perform when it disappears after the stressor has gone and the task is accomplished. There is no reason why this would be different for animals. We believe that a happier animal will be more efficient because negative stress is depressing the immune system and has an effect on productivity: all the metabolic energy produced from feed intake, going into stress and mental or physical discomfort, is not available for production.

In this vision, animal welfare is much more than just an isolated aspect within the whole production process. Precision Livestock Farming (PLF) will have to come up with new technologies to monitor animal welfare in an objective, fully automated and continuous way by using image-, sound-and/or sensor technology. The other urgent need is that the PLF systems do not only monitor but also deliver active advice to the farmer on what to do when alarms are given, based upon measurements on the animal.

## From biology to technology

Many people claim that the future is in big data, the Internet of things (IoT) and artificial intelligence (AI) and in the software rather than in the hardware. We should, however, not forget that living organisms are very complex, individually different and time-varying



and that we need technology that can cope with this. At every moment, accurate, reliable and affordable hardware for image-, sound- or sensing technology will remain very important to create successful PLF products. The synergy and collaboration between biology and technology, therefore, becomes more important. So far, we have mainly used technology developed for some purpose and tried to apply it later on animals. We should, however, start from the animal and check which variables we need to measure, how often, with what accuracy and with what technology. Then we can define the specs and develop the appropriate technology. Solutions that are developed in this concept will consider the living organism from the beginning.

### Get more consumer interest

Many people claim that animal welfare is important but it remains questionable whether people are prepared to pay more for such an animal-friendly product. To solve this, we first need a solution that allows consumers to find such animal-friendly products in a reliable and easy way. We require a

more trusted system that works in an easy way and that is convincing for users to catch appropriate objective information. For Europe, it is important to develop such working systems that will help consumers to trust the value of animal welfare in the animal products they buy.

### Human-animal relationship

All children, farmers, researchers and others working in an intensive way with animals, know from experience that animals are sensitive to the way in which people treat them. Though animals are individually different, this human-animal interaction will also be measurable by PLF technology like, for example, in the milking parlour for cows.

Today, we have no idea if and in what way the farmers' stress is influencing animal welfare. In case there is a relationship, then it seems logical that this relationship will influence the production results as well. We put rather intelligent animals like pigs in a very boring environment and the possibilities to use PLF technology to create an interesting, adventurous environ-

ment for curious animals is not so much used yet, so there is another opportunity here to realise playful events and environments for our animals to give them a life that is worth living.

#### Acknowledgements/references

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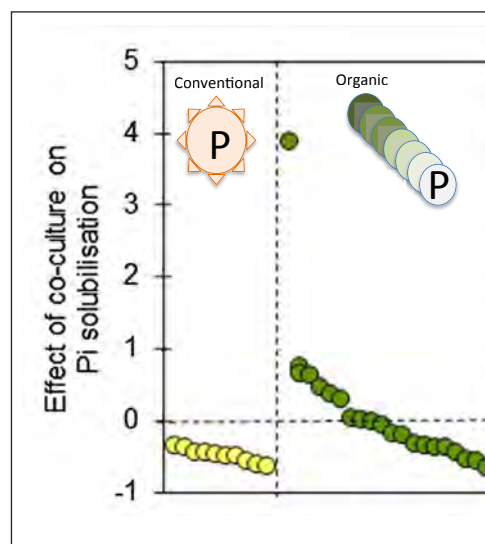
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# Agriculture: Key to eradicating hunger and securing food

Cristina Cruz from FCiencias.Id explains why agriculture is the key to accomplishing the UN Sustainable Development Goals of eradicating hunger and securing food

**A**griculture is the key to accomplishing the UN Sustainable Development Goals of eradicating hunger and securing food for a growing world population of 9–10 billion people by 2050, which may require the doubling of global food production in a world of increasing environmental uncertainty. So, how are we going to achieve this if currently, agriculture is, at the same time, the biggest contributor to and the most affected activity by the global changes? Agriculture is also the single largest user of freshwater in the world, with 70 % of the totally withdrawn water of almost 6000 km<sup>3</sup> year<sup>-1</sup> being diverted for agriculture, which has resulted in approximately 25 % of the world's major river basins no longer reaching the ocean. Agriculture is the world's largest contributor to altering the global nitrogen and phosphorus cycles. Anthropogenic uptake of N from the atmosphere today exceeds the natural global uptake of N for biomass growth and currently at approximately 150 Tg N year<sup>-1</sup> the global uptake far exceeds the safe ecological limit of 62–82 Tg N year<sup>-1</sup>.

The challenge is obviously how to produce more food with fewer resources. Sustainable intensification, in this context, seeks to increase agricultural output while keeping the ecological footprint as small as possible. The aim is to design multi-functional agro-ecosystems that are both sustained by nature and sustainable in their nature. But to do this, we have to change our



*Fig. 1. The legacy of the farming system on the effect of coculture on Pi solubilisation when PSB was grown in pairs of isolates. PSB pairs resulted in significant effects of coculture on Pi solubilisation being positive (i.e. cooperation) or negative (i.e. antagonism). Symbols: yellow for combinations of PSB isolated from conventional and green for combinations of PSB isolated from organic. Conventional management is selecting for organisms with a high individual potential to solubilize Pi and organic management is selecting for food webs.*

mechanistic view of the agro-ecosystem by capitalising on ecological processes in agro-ecosystems.

**“Agriculture is the key to accomplishing the UN Sustainable Development Goals of eradicating hunger and securing food for a growing world population of 9–10 billion people by 2050, which may require the doubling of global food production in a world of increasing environmental uncertainty.”**

The Bioclub project (PTDC/AGR-PRO/1852/2014) aims at incorporating ecological approaches that make smart use of the natural functionalities into the agro-ecosystem management as an important part of the development of the sustainable intensification of agriculture. However, our fundamental understanding of soil ecology is still a limiting factor to a bio-based management of the agro-ecosystem.

Let's take the bio-transformations of phosphorus, as an example.

The productivity of most agricultural systems is limited by phosphorus. However, in conventional farming, 60–90% of the soluble inorganic phosphate (Pi) applied to soils as fertiliser is rapidly immobilised after application, making it unavailable to plants. In contrast, organic farming replaces synthetic fertilisers and pesticides with biological inputs, so microbial processes are essential for its productivity and sustainability.

Several soil microbes have been identified as promoters of plant growth due to their ability to solubilize Pi. However, the use of Pi – solubilising inoculants provides inconsistent results, even when the microbes have the potential for high Pi solubilisation. We tested the legacy of the farming system (conventional or organic) on





the interactions among phosphate solubilising bacteria (PSB) and phosphate solubilisation. We determined the *in vitro* Pi solubilisation potential of bacteria isolates itself conventional and organic farming and grows them in monoculture, or in pairs, to test for their antagonism or cooperation in Pi solubilisation.

**“The productivity of most agricultural systems is limited by phosphorus. However, in conventional farming, 60–90% of the soluble inorganic phosphate (Pi) applied to soils as fertiliser is rapidly immobilised after application, making it unavailable to plants.”**

When grown in mono-culture, PSB isolated from conventional farming solubilised more Pi, but when grown in pairs, these PSB solubilised the least Pi. Furthermore, when the pairs included only PSB isolated from con-

ventional farming, no Pi – solubilising cooperation was observed, that is, Pi solubilisation by pairs were lower than in monoculture. When PSB isolated from organic farming were present in the pairs, ~40% of the combinations resulted in P solubilising cooperation. This implies that the two farm management systems select distinct P solubilising microbial communities are:

- Conventional selects for more efficient individuals and;
- Organic selects for more efficient communities (soil food webs).

These results, described in more detail in Melo et al 2017, offer evidence for a farming system legacy influencing the biotic interactions among PSB. And questions arise about the best strategies to convert intensive into sustainable farm systems. But it also provides

a strong driving force for a deeper understanding of the bio-transformations of the resources used in agriculture and the need for adequate farming management concerning the biological processes they promote.

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# Environmental policy in the UK: Investing in the soil bank

Graeme Willis, Senior Rural Policy Campaigner at the Campaign to Protect Rural England (CPRE) explains why soil has long been a Cinderella issue of environmental policy in the UK

**A**mid the general political turmoil, one government department, in particular, has been energised by the repatriation of policy in anticipation of the UK leaving the European Union (EU) and the consequential removal of the constraints of the Common Agricultural Policy (CAP). With Michael Gove at its helm, the Department for Environment, Food & Rural Affairs (DEFRA) has taken significant steps to put in place new agricultural legislation and policy and a government 25 Year Environment Plan. Together, these will drive the transformation of how public money is invested in land management and should reward production that is harmonised with restoring the natural environment to health. A National Peat Strategy for England and an Environment Bill are also anticipated.

Of course, one caveat is that much of this policy is embryonic: it's too early to say whether it can deliver on its aspirations and, crucially, whether HM Treasury will fund it to do so. But this policy constellation gives us hope in many areas, and especially in one unexpected bright spot that is the extra attention given to healthy soils. Soil has long been a Cinderella issue of environmental policy.

For instance, there are established EU Directives on water, air and noise but on soils, a proposal could not be agreed and was abandoned. Despite the exceptional importance of healthy soils to UK food supply and a growing understanding of how they underpin a host of other environmental services – clean water, flood management, biodiversity, carbon storage – there has been a distinct lack of policy targeted directly at tackling soil issues.

The need to act should not be doubted. Evidence of the problems soils face and the costs this places on farmers, the environment and society are well known

– and acknowledged by the government. One-third of all UK soils are degraded and a third of all arable soils at risk of erosion. Of our peatland – 1.4 million hectares in England alone – just 1% is undamaged. Peat soils in the East Anglian Fens, some of the most productive farmland, are losing soil at 1-2 cm per annum and could be lost as rich organic soils within a couple of decades. The costs of this degradation to society have been estimated at £1.2 billion a year.

Nearly £600 million of this relates to greenhouse gas emissions alone. And significant functions of soil and their depletion are missing from this analysis, so the avoidable costs may be much greater. Despite this, since the turn of the century, the government has failed to extensively and routinely sample soils and to develop the much-needed understanding of their status. Policies to halt their degradation and to support good stewardship and make it pay have faltered as a consequence.

If the need to act on land and soil management is now well established, the desperate urgency of action has been very recently emphasised. Few will have missed the special report from the Intergovernmental Panel on Climate Change (IPCC), in October 2018, on the need to drive down greenhouse gas emissions well before 2030. They call for deep emissions cuts and far-reaching transitions in all sectors, especially land use. The Royal Society and the Committee for Climate Change have echoed this by calling for immediate action to ramp up sequestration of carbon in soils. The Royal Society argues this is immediately doable, scalable and that UK soils could store up to 31 MtCO<sub>2</sub> pa for the critical decades ahead.

The new Foresight Food and Farming Report from CPRE grapples with these many and compelling issues





from the starting point of soils, the threats they face and why we should care. From there, its focus is to explore promising and primarily farm-based approaches which could help drive the transformation of land management needed to cut soil degradation and regenerate soils to a healthier state: conservation agriculture, agroforestry, pasture-based farming and wet peat farming or paludiculture.

These approaches, scaled up, could deliver multiple benefits we need from a repurposed countryside, and not least but not only to address the existential threat of climate change. They offer the potential for productive, profitable and more resilient farming, more diverse systems that can work with and restore nature, more varied landscapes, and new products and possibilities for restored peatlands. In so doing, they also offer a pathway that can make sense to the farmers and land managers who are being called upon to deliver on ambitious environmental goals while running a business and making a rewarding living.

Tackling climate change is imperative and looking after soils better as part of the answer is gaining support. The report closes with recommendations for the government to bring forward policies to build on progress in 2018. These must put the proper valuation of soils and what they do for us, halting soil degradation, regenerating soils and sustainable low carbon farming at the heart of the government's plans for farming and the countryside it stewards. ■

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# The future of food and agriculture

Håkan Sandin explores the future of the world's food supply and the need to reduce unsustainable agriculture, in this analysis

In the future, food will be produced closer to the consumer. This means what we eat is in the future, produced in urban environments using raw materials coming from the city, the forest, the sea and our fields. The importance of agriculture, however, for human livelihood and survival, will in the long run change dramatically and be reduced mainly due to environmental reasons.

It is also reasonable to believe that our food is produced in new production systems. These production systems will be sustainable, circular and mutualistic. Systems where we control all flows and where emissions and surpluses have been minimised to the non-existent. This production will take place in industrial areas fully specialised in producing food.

This production will also get its inspiration from the research that points to what is good for the human being and keeps us healthy. Thus the foods we will produce, are largely the ones we recognise, but there are also more unusual foods not known to many people and those that are brand new innovations.

Also, we will learn to understand that we cannot achieve a sustainable, stable, environmentally friendly and competitive food production unless we use much more but renewable energy.

## **The importance of big scale industrial agriculture will be reduced**

Agriculture of today is harmful to the human population of the world, to the wild nature including all wildlife such as animals, plants, etc. It creates a continuous and lasting imbalance between humans and nature. Agriculture is overconsuming land resources, not sustainable fertilisers and plant protection chemicals when producing food that the human race does not need for a healthy and happy life.

This is so serious that it must end. However, in a conversion process that will take a long time, we need to find solutions to very complex issues that involve all the people who today produce our food.

We can however not continue to produce cereals, such as for instance wheat and corn in huge areas to bake bread and produce meat. Bread and meat are overconsumed to the extent that an overwhelming number of people suffer from welfare diseases such as obesity and psychosomatic diseases.

## **Mutualistic Industrial Food Production**

We must introduce a whole new and holistic way to look at the world's resources. The world we have created for a growing world population is based on increasing consumption of

finite resources such as oil, phosphorus and land. This was done from the perspective that we have had to store grains in enormous quantities to feed ourselves and our animals to survive after the world wars.

We do not need this anymore. Recently, research and development have shown that we can survive from resources we have very close at hand and that we can produce on leftovers that exist where we live our daily lives.

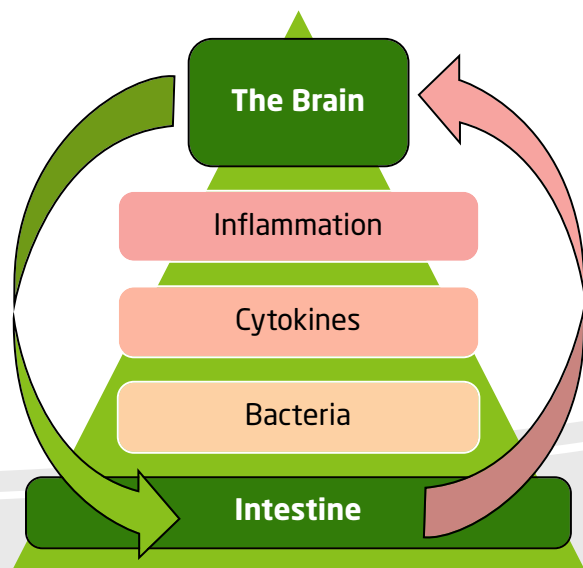
One way of thinking is that we take inventory on all the resources in our cities where we live. At the same time, we are considering how we can best use these resources. We will then discover that we have a lot of unused infrastructure such as streets, squares, houses and factories and unused land areas etc. We will also find that we can warm our communities more efficiently and more environmentally friendly while learning to take care of all unused materials.

Those who worry that we do not have use for our farmland will discover that we need it to produce other more important and crucial things for the human survival on our planet. This is also about more food production in a smarter way, more forests for food and materials of all kinds and crops for industrial smart and innovative applications, as raw materials for the food, housing and automotive indus-

## **If You eat harmful food**

- Nasty bacteria infect the bowel.
- They cause leakage and spread in the body.
- Cytokines are also released.
- They cause inflammation.
- The brain is affected.
- Hormones that make us feel good are inhibited.
- We become depressed and sick.

This whole process can be reversed by good diet, which creates a good intestinal flora of bacteria



tries, to name a few examples. This development is already on its way and we need to release land resources for this purpose.

One way to do this is to produce food in industrial areas specially designed for this purpose. In this way, we can create customised circular and sustainable food production. As we will continue to need a lot of energy, you could call these areas Energy and Food Parks, where you conduct a Mutualistic Industrial Food Industry.

### Healthy foods

A harmful process occurs when we eat a one-sided diet (see illustration above), too little fibre, too much sugar and meat. People feel their best when eating with great variety; lots of fish, fruit, vegetables and fermented food.

If we do, we can reverse this malicious process in a few months. Research has shown that we can get rid of very serious chronic welfare diseases and mental illnesses. The new discovery is that the bacteria in our stomach are

those who keep us healthy if we only care about them, i.e. giving them the right kind of food.

Ten psychobiotic advice that will strengthen your health:

1. Eat varied. Diversity, diversity, diversity.
2. Eat a lot of fiber. prebiotics
3. Eat fermented food. probiotics
4. Be careful with antibiotics.
5. Minimize sugar.
6. Eat sparingly with meat.
7. Cook and eat natural food.
8. Exercise semi-solid.
9. Exercise regularly.
10. Reduce stress. Meditate

In the future, of course, we will only produce such foods that are good to ourselves as human beings, the environment and our economy.

### Need for more energy

In order to achieve this, we must understand that we also need more energy. However, our energy sources need to be renewable.

We also need fuel, lubricants, fertilisers and plant protection products. Even these must be renewable and work in a circular system.

Finally, it can be said that since our transports are increasing both from a global perspective and also the transports to the consumer, we must ensure that these also are sustainable.

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# Water for plant growth: The foundation of the global food supply and ecosystem services

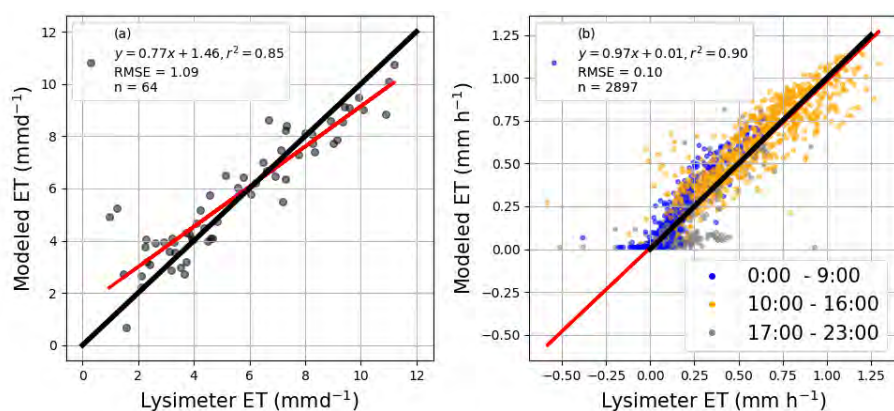
Professor Robert Aiken, Research Crop Scientist at the Northwest Research – Extension Center and Dr. Ramesh Dhungel, Research Associate at Kansas State University both explain why water is required for plant growth, the foundation of the global food supply and ecosystem services

**W**ater is required for plant growth – the foundation of global food supply as well as ecosystem services. Hence, the linkage of food security and water security.

Most climate change impacts are expected to affect the water sector (IPCC, 2014). These impacts include altered precipitation patterns, reduced availability of freshwater, and reduced water quality. Climate change impacts will likely exacerbate competition for water among agriculture, industry, ecosystems and settlements (MacAlister and Subramanyam, 2018).

Reliable crop water metrics provide computational tools that are particularly suited to the agricultural landscape. Robust survey tools utilise satellite imagery to detect trouble spots, such as drought monitoring services. However, satellite imagery is frequently obscured by factors such as cloud cover, limiting application to water management.

Recent advances in computational tools support use of physically-based energy balance modules to reliably calculate crop evapotranspiration (ET) at landscape and regional scales (Dhungel, et al., 2016). The Backward-



*Figure 1: Scatterplot of a) daily and b) hourly evapotranspiration (ET) calculated by the revised BAITSSS energy balance model (Dhungel et al., 2016) in relation to field measure of ET (lysimeter) for corn between May 23, 2016, and September 26, 2016, near Bushland TX, USA. Linear regression (red lines) and one-to-one correspondence (black line) are also indicated.*

Averaged Iterative Two-Source Surface temperature and energy balance Solution (BAITSSS) is a physically-based ET model capable of point scale and landscape simulation of soil water using a vegetative canopy, soils and weather data. Field comparisons with precise field measurements demonstrate the validity of this modeling approach (Figure 1, Dhungel et al., in review).

Application to water management is illustrated for a groundwater management district in northwest Kansas, USA. With an improved algorithm, ET was calculated for a township in western Kansas (Figure 2), a region of substantial groundwater depletion. Figure 3 shows water balance components for a particular sampled pixel.

Comprehensive ET analysis provide water metrics for crop systems ranging from dryland to full irrigation. These information services support initiatives such as Local Enhanced Management Areas in Kansas, which operate multi-year water management plans that have resulted in 20% or more reductions in irrigation withdrawals.

## Acknowledgement

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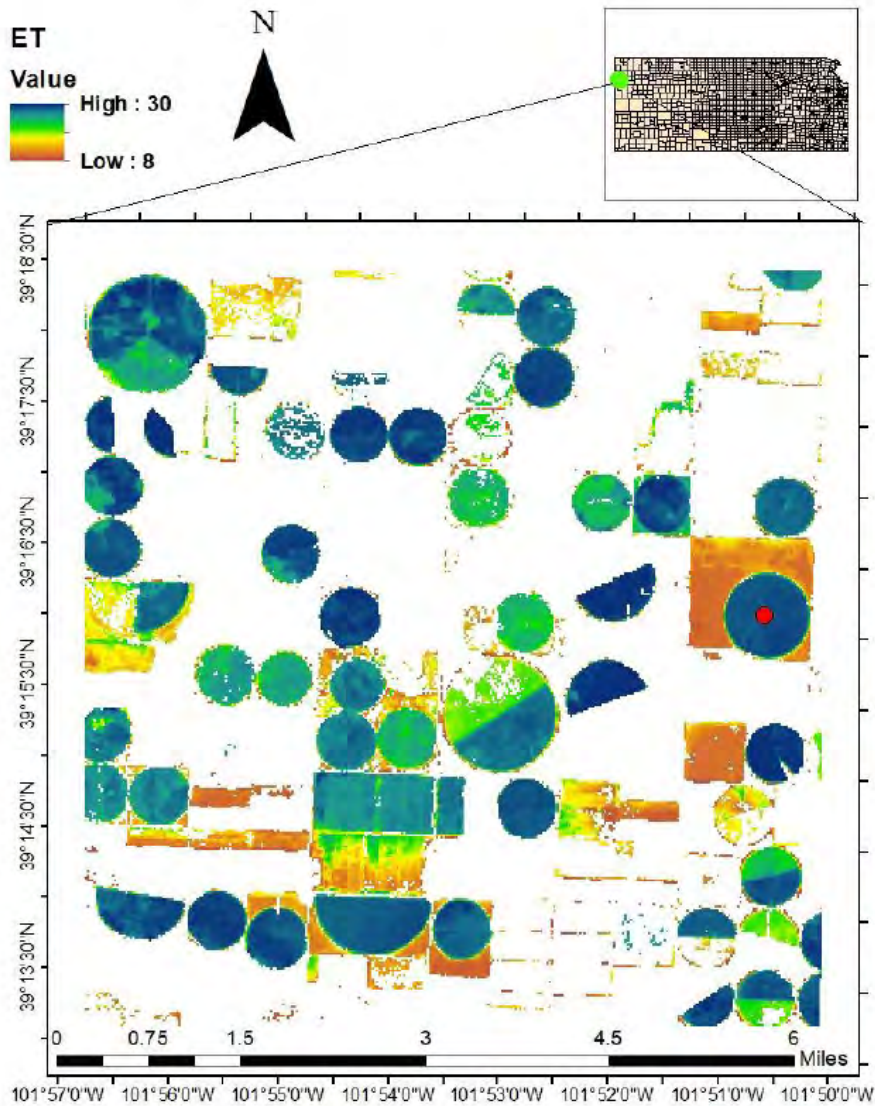


Figure 2: Cumulative water use (evapotranspiration, ET, May 10, 2013, through September 15, 2013) of corn for Township 9S, Range 41W, in northwest Kansas, USA. A township comprises 36 square miles (9,324 hectares). The colour scale indicates a range in ET of 8 to 30 inches (203 to 762 mm). Only pixels classified as 'corn' (U.S. National Agricultural Statistical Service) are indicated. Details of the water balance are provided (Figure 3) for a sample pixel (indicated as a red dot, 101° 50' 42\"/>

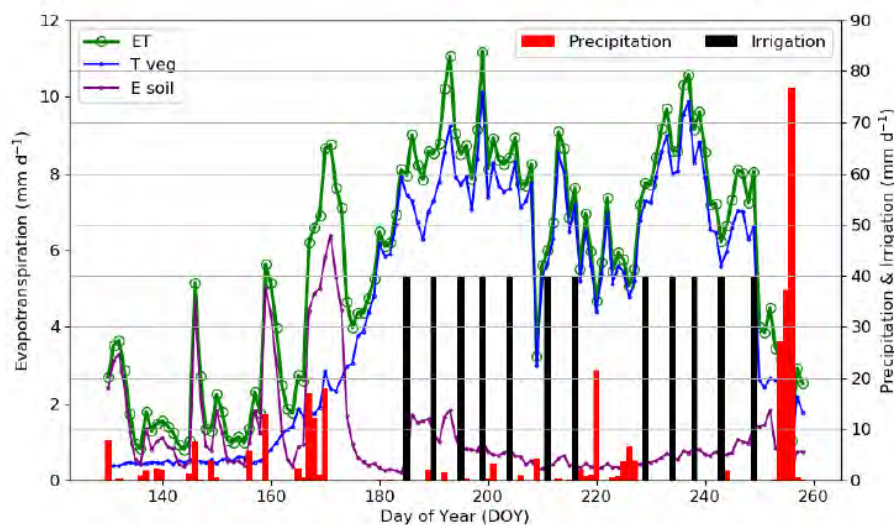


Figure 3: Daily evapotranspiration (ET), evaporation (E), transpiration (T), irrigation and precipitation, calculated by the BAITSSS energy balance model, is shown for a sampled pixel in northwest Kansas, as indicated in Figure 2.

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# Protecting and promoting U.S. agricultural health

The Animal and Plant Health Inspection Service (APHIS) is a multi-faceted agency within the U.S. Department of Agriculture. APHIS has a wide-ranging mission that includes protecting and promoting U.S. agricultural health, as this article by Open Access Government Editor, Jonathan Miles uncovers

**T**he Animal and Plant Health Inspection Service (APHIS) is a multi-faceted agency within the U.S. Department of Agriculture. APHIS was established in 1972, and today, it has a wide-ranging mission that includes protecting and promoting U.S. agricultural health, regulating genetically engineered organisms, carrying out wildlife damage management activities and administering the Animal Welfare Act.

## The work of APHIS in protecting agricultural health

Looking more closely at the work of APHIS in protecting agricultural health, they operate 24 hours a day, seven days a week to defend the U.S.'s animal and plant resources from agricultural pests and diseases. Did you know that if the Mediterranean fruit fly and the Asian longhorn beetle (ALB), two major agricultural pests were left unchecked, several billions of dollars in production and marketing losses would result each year? Another fact to underline in this vein is that if foot-and-mouth disease or highly pathogenic avian influenza were to take hold in the U.S., foreign trading partners could invoke trade restrictions and of course, producers would suffer devastating losses.

We know that when a pest or disease of concern is detected, APHIS implements emergency protocols and partners with the affected states to speedily manage or eradicate the outbreak. Such an aggressive approach is the one APHIS likes to take and it has enabled them to successfully respond to and prevent potential pest and disease threats to U.S. agriculture.

In responding to needs expressed by Congress and the U.S. inhabitants, the mission of APHIS has grown over time to incorporate additional issues, such as regulation

of genetically engineered crops and animal welfare; wildlife damage and disease management; regulation of genetically engineered crops and animal welfare; and protection of public health and safety; plus natural resources that are vulnerable to invasive pests and pathogens.

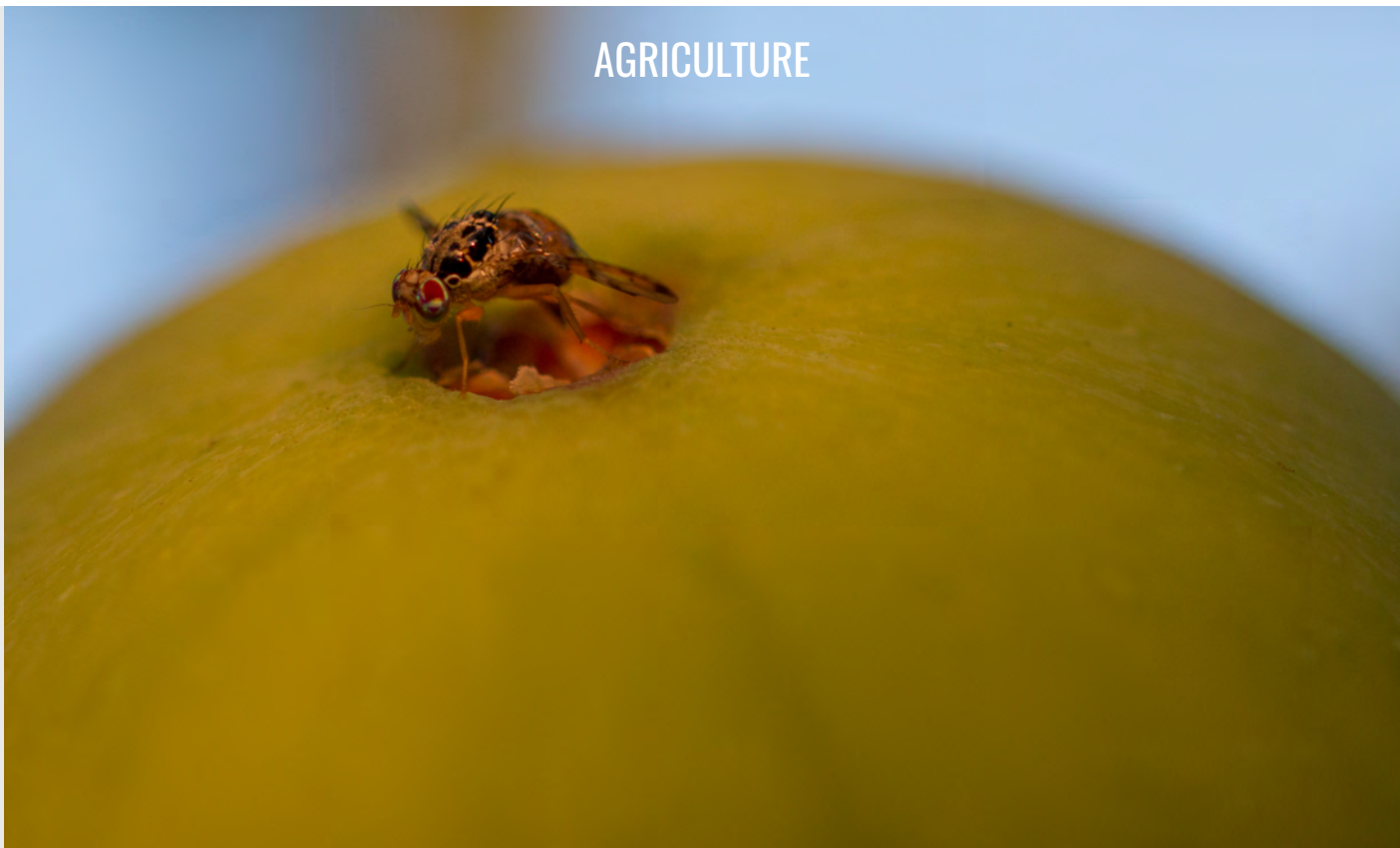
## National Fruit Fly Cooperative Control Program

A recent example of APHIS's work was highlighted on 16th November 2018 when it was announced that they had finished the final environmental impact analysis that was needed under the National Environmental Policy Act for its National Fruit Fly Cooperative Control Program, which intends to protect U.S. agriculture from exotic fruit fly incursions. With this important action complete, APHIS issues an environmental impact statement so it can carry on applying the most recent technology and science towards its efforts to control and eradicate exotic fruit flies and, therefore, support U.S. farmers.

In essence, the National Fruit Fly Cooperative Control Program protects the health and value of U.S. agricultural resources by preventing exotic fruit fly populations from becoming established in the country. The press release provides us with further details as follows: "We know that fruit flies pose a serious economic threat to agriculture because they feed on flowers and fruits, are highly mobile, and have a high reproductive potential. APHIS works in cooperation with State agriculture officials to detect and eradicate non-native fruit flies." <sup>(1)</sup>

## The Asian longhorn beetle (ALB)

Picking up on an area of work mentioned earlier in this



article, let's take a closer look at the Asian longhorn beetle (ALB). Prior to winter 2018, APHIS reminded the public not to move wood out of areas quarantined for the ALB. The announcement makes the important point that people should follow state and federal laws, which restrict the movement of woody material, to keep the tree-killing pest from spreading outside of quarantined areas in Ohio, Massachusetts and New York.

Josie Ryan, APHIS' National Operations Manager for the Asian Longhorn Beetle Eradication Program spoke about the progress being made in the U.S. when it comes to the fight against ALB. "We're making progress in the fight against ALB. We removed quarantines in two areas of Ohio this year alone, but we still must prevent the beetle's spread to other places. As people begin using wood stoves and fireplaces, we are reminding the public to follow the quarantine laws, especially when stocking up on firewood. We cannot eliminate this beetle without the help of residents and business owners." <sup>(2)</sup>

In 2018, APHIS reminded citizens that August is the best time of year to check trees for signs of the ALB. With August being Tree Check Month, APHIS explained in their own words the importance of checking trees. "Asian longhorn beetle-infested trees are safety hazards. You don't want them on your property because they can drop branches and treetops, and storm damage becomes much worse," said Josie Ryan. "So to make sure your trees are healthy, now is the

time to go outside and look at them for signs of the beetle", she added. <sup>(3)</sup>

## Protecting, promoting and preserving U.S. agricultural health

In closing, these examples of agricultural pests bring us back to the wider aims of the APHIS that includes protecting, promoting and preserving U.S. agricultural health. Certainly, the APHIS' Plant Protection and Quarantine (PPQ) program specifically, "safeguards U.S. agriculture and natural resources against the entry, establishment, and spread of economically and environmentally significant pests, and facilitates the safe trade of agricultural products." <sup>(4)</sup>

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- 3 [https://www.aphis.usda.gov/aphis/newsroom/news/sa\\_by\\_date/sa-2018/alb-tree-check-month](https://www.aphis.usda.gov/aphis/newsroom/news/sa_by_date/sa-2018/alb-tree-check-month)
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### Jonathan Miles

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# Trees in the urban environment: ‘Seeing’ roots underground

Dr Nina Bassuk, Professor at the Urban Horticulture Institute, School of Integrative Plant Science explores seeing roots underground when it comes to research into trees in the urban environment

Scientists who study trees in the urban environment have a great challenge when it comes to measuring and ‘seeing’ root growth underground. In the past, if roots were studied at all, cores were pushed into the ground and then extracted provided a somewhat random sub-sample of root growth. In another instance, clear tubes called mini rhizotrons were used to visualise tree roots by placing the tubes in the soil and lowering a camera into the tube to take a picture of roots that grew near the tube. This was also a hit or miss sample of roots that may or may not have intersected with the clear tube. Still another tool, an air excavation probe, has more recently been used to uncover the roots system of a tree without damaging the root system. While effective, this process is very time consuming depending on the soil type and tree size. None of these techniques can locate and measure roots under the pavement.

The use of Ground Penetrating Radar (GPR) is a relatively new technique to study roots. GPR is an established non-invasive (i.e., non-destructive) inspection method that has been used worldwide for more than thirty years to locate subsurface objects such as pipes, utilities, and other engineering and environmental targets.

One of the main worldwide uses of GPR is in concrete inspection, where



*Non-porous and porous asphalt side by side*

the integrity of the structurally supporting reinforcement is examined along with the integrity of the concrete matrix itself. Although this technology has a long history of use in archaeology and engineering to locate antiquities and utilities, the practice of using it to map roots in urban soils, which can be compacted, layered and discontinuous, is comparatively new.

GPR measurement as a method of mapping tree roots has several advantages over other methods:

- 1) It is capable of scanning root systems of large trees under field conditions in a relatively short time;
- 2) It is completely non-invasive and does not disturb the soils or damage the trees examined;

3) Being non-invasive, it allows repeated measurements that reveal long-term root system development;

4) It allows observation of root distribution beneath hard surfaces (e.g., concrete, asphalt, bricks, pavers, roads, buildings) and;

5) Its accuracy is sufficient to detect structural roots with diameters as small as 1 cm.

GPR inspection employs electromagnetic waves, which will deflect, or refract from a boundary between objects with different electro-magnetic properties. The electromagnetic material property that creates the contrast and causes reflections is the dielectric, which is a dimensionless quantity relating to the materials behaviour

*Ground Penetrating Radar scans of root growth under the pavement*



when subjected to an electric field. The larger the difference between the dielectrics of two different materials, the larger the radar wave.

For example, the dielectric of water is 81 and that of an average soil is approximately 13, producing a “dielectric contrast” of 6.2:1 (81/13), which is large and will cause most of the radar wave energy to be reflected back to the surface antenna. Root detection is possible in principle because of the water content within the woody root provides an excellent contrast with the soil media.

Before this technology can be used to its fullest, ‘ground truth’ studies needed to explore the limits and resolution of GPR as a tool or locating tree roots on development sites and under the pavement. This ‘ground truth’ comparison between predicted GPR and actual visualisation of the root zone was undertaken in 2011, resulting in a high degree of agreement between

methods. With increasing confidence, we decided to measure tree root growth under porous and non-porous asphalt.

In 2005, a 12-car parking lot was designed and constructed in partnership with the City of Ithaca, NY, USA. This new 45-metre x 6-metre parking lot was divided in half, with the southern half of the lot paved with 8 cm of porous asphalt while the northern half used an 8 cm layer of the medium-duty traditional impervious asphalt surface. Prior to paving, the entire lot was excavated to a depth of 0.6 metres and CU-Structural Soil® (structural soil) was added and compacted to the required density to support the pavement and cars. Structural Soil is a highly porous medium that can support the pavement while still allowing roots to grow within it.

In 2012, 2015 and 2016, root growth of the trees under porous and non-porous asphalt was measured using

Ground Penetrating Radar. Twelve GPR scans were performed on the trees growing under porous and non-porous asphalt. Each scan covered 30 cm wide by 6 metres long by 75 cm deep. Root density was measured at three depth layers and expressed as roots per linear foot. Root growth was found to be much denser and deeper in the soil under the porous asphalt presumably because of greater access to water. Additionally, tree growth above the porous asphalt was also improved.

This gave us confidence to conclude that the growth we were measuring above ground corresponded to greater root growth and water uptake below ground. Moreover, the use of Ground Penetrating Radar has added a very useful tool to the scientists’ toolbox when trying to understand urban tree growth in the inner city.



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# Developments in food research: Exeter University students join the fight to save the banana

Banana exports are threatened by pests, diseases, and climate change. Students at Exeter University have joined researchers to address food research challenges, as Dr Daniel Bebber, Senior Lecturer in Microbial Ecology describes

**E**xeter University is in the vanguard of global efforts to tackle the many challenges facing banana producers around the world. Chief among these the fungal disease *Fusarium Wilt*, better known as Panama Disease, which is spreading out from Asia to threaten the livelihoods of farmers growing the Cavendish banana variety, which makes up the vast bulk of bananas seen on supermarket shelves in the U.S. and Europe.

Of course, many hundreds of other varieties are grown across the tropics for local consumption, and many of these are naturally resistant to the disease. However, these varieties remain vulnerable to dozens of other fungi, bacteria, viruses, nematodes and insects, which exert a heavy toll on farmers in developing countries. Dan Bebber and colleagues at Exeter University are funded by the UK Global Food Security programme and the EU Horizon 2020 programme to investigate the various threats to banana production and work towards sustainable solutions. That won't be easy – *Fusarium Wilt* has so far evaded attempts to develop fungicides against it, while another major fungal disease, Black Sigatoka, requires up to eighty fungicide sprays per year to control it.



*Diseased bananas in a plantation in Java, Indonesia*

*Image: Clare Thatcher*





Image: Dan Bebber

*Dr Dan Bebber at a banana research station in Costa Rica, as part of an EU-funded project to find biological controls for major pests and diseases of the crop*

As part of Exeter's work, undergraduate and graduate students are helping to conduct cutting-edge science and learn valuable research techniques for their future careers. The Exeter University MSc in Food Security and Sustainable Agriculture is an exciting one year course which welcomes students from around the world to learn about the latest developments in food system research. MSc students also undertake a six-month research project on a topic of their choice, working closely with academics who are leaders in the field.

In 2017, four MSc students undertook projects relating to bananas. Omotola Odetayo from Nigeria worked with the Eden Project in Cornwall to investigate the effects of a potential biological control for Fusarium Wilt. Chinese

researchers have found that a type of leek appears able to protect banana plants from the fungus when grown among them, but the wider effects on soil micro-organisms are unknown. Omotola used DNA sequencing to determine how soil fungi are affected, finding that the Chinese leeks appear to increase soil fungal diversity. Now, an undergraduate biology student at Exeter, Hannah White, is taking this research forward.

MSc student Clare Thatcher travelled to Java, Indonesia, to work with small-holder farmers on the disease problems they face. She found that banana farms are affected by at least three major problems, but that farmers have no training in disease control or biosecurity measures. She is now developing a handbook in the local language to help farmers understand and tackle these problems. Importantly, Clare used drone imagery to map healthy and sick banana plants, showing that most of the sick plants are close to paths in the plantations, highlighting the need for clean cultivation practices to prevent the spread of disease.

MSc student Iqra Aslam travelled to Sindh Province in Pakistan, one of the most recent areas to be invaded by Fusarium Wilt. Working with the Pakistan Agricultural Research Council, she mapped the extent of the disease invasion, finding that farmers are poorly informed about how diseases spread and that transport of infected plants is an important means of invasion. Lakshmipriya Venkatesan, also on the MSc, worked with Prof David Studholme to identify disease resistance genes in DNA sequences of a variety of different bananas. These genes could form the basis of

future breeding or even gene-editing programmes to create the next generation of bananas.

Exeter also has several undergraduates working on bananas. As mentioned, biology student Hannah White is taking forward the soil fungal diversity analysis, while Rachael Piper, who won a summer studentship from the British Society for Plant Pathology, is developing a computer model to predict the future spread of banana diseases around the world. Imogen Lang, also a biologist, is working with Prof Sarah Gurr and Dr Will Kay on the life cycle of the Fusarium Wilt fungus – important fundamental biology which could hold the key to stopping this disease.

The production of bananas, like all other crops, is continually threatened by new and virulent pests and diseases. Training young scientists to tackle these problems is a fundamental role that research-intensive universities like Exeter play.



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# Harnessing the genetic diversity of a dynamic crop: Cowpea

Shawn Yarnes from The Integrated Breeding Platform highlights harnessing the genetic diversity of a dynamic crop, cowpea and why it is important today

Public plant breeders are working in international collaboration to harness the genetic diversity of cowpea (*Vigna unguiculata*). Cowpea is a leguminous crop critical to food and economic security in hot semi-arid regions of the world. Most of the 5.6 million tonnes of dried cowpea grain produced annually are grown in West and Central Africa<sup>1,2,3</sup>. Nigeria is the world's largest producer of cowpea, followed by Niger and Burkina Faso<sup>4</sup>. Production is increasing, but yield is hampered by lack of cultivars with appropriate tolerance and resistance to biotic and abiotic stress<sup>5</sup>.

Cowpea is a dynamic crop and economic resource for farmers cultivating marginal agricultural land and is a food source during the "hungry season" when last year's grain stores are depleted. Cowpea is eaten as both a vegetable and as grain and can serve a dual-purpose as animal fodder. Variety development differs based on purpose, with grain-types tending to be erect and early maturing. Most grain-types mature less than 100 days after planting<sup>3,6</sup>. Green leaves and young pods are edible, and mature grain is high in protein (20-25%)<sup>1,4</sup>. Peas can be harvested fresh or dry but are generally collected fresh in dual-purpose cultivation to avoid leaf senescence before hay-harvest<sup>2,4</sup>.

Cowpeas are well adapted to sandy soils and low input farming practices. Little nitrogenous fertiliser is needed due to N-fixation by *Bradyrhizobium* spp. in root nodules<sup>7</sup>. Cowpeas enrich the soil with nitrogen and are often rotated and intercropped with: maize, sorghum, millet, and cassava. In Sub-Saharan Africa rotating cereals after legumes yield significantly more than continuous cereal production, mostly due to enhanced soil nitrogen<sup>2</sup>. In regions with low soil phosphorus, cowpeas do benefit from P fertilisation. Variation in P-efficiency and N-fixation rates have been characterised, but not fully optimised in cowpea cultivars<sup>1,8</sup>.

Cowpeas are heat and drought tolerant, with some cultivars tolerating as little as 300mm of rain<sup>3</sup>. Cowpeas recover well from early season drought, but drought during flowering and pod-filling has lasting negative impacts on yield and quality even after re-watering. Drought tolerance is a complex trait, but many components are understood. Early maturation and other traits, like photoperiod-insensitivity, confer drought tolerance because they give farmers the flexibility to plant when rain is most likely to coincide with flowering<sup>4,6</sup>. Extra-early maturation (45-50 days after planting) identified in a landrace has recently been introgressed into a medium maturing Ghanaian variety<sup>6</sup>.

Many pests and diseases affect cowpea, resulting in partial to total crop loss. Management practices such as crop rotation, maintenance of soil fertility, and chemical applications can alleviate pests and diseases, but improved genetic resistance is imperative to sustainable intensification of production. Fortunately, resistance to many pests (aphids, root-knot nematodes, foliar thrips, and *Striga*) and diseases (*Fusarium* wilt, bacterial blight, *Macrophomina* disease, and viruses) have been identified in diverse cowpea accessions<sup>4,5,9</sup>.

Cowpea's tremendous genetic diversity is captured in germplasm collections worldwide, and new sources of alleles are continually being identified and genetically characterised. Important traits, such as black seed coat colour, pod shattering, and seed size have been recently mapped and candidate genes proposed<sup>10,11</sup>. The immediate breeding challenge is to combine multiple sources of genetic diversity into cultivars suitable to local environments and markets. Grain value is driven by the culinary preference for seed colour and texture.

One effort currently underway is the evaluation of a multiparent advanced generation inter-cross (MAGIC)

population created from eight genetically diverse elite lines. The MAGIC population's 305 lines contain previously uncharacterised genetic combinations<sup>5</sup>. The International Institute for Tropical Agriculture (IITA) along with several national agricultural research organisations are evaluating these lines across Sub-Saharan Africa and determining their suitability as breeding material and possible new varieties.

**“Cowpea is a dynamic crop and economic resource for farmers cultivating marginal agricultural land and is a food source during the “hungry season” when last year’s grain stores are depleted. Cowpea is eaten as both a vegetable and as grain and can serve a dual-purpose as animal fodder.”**

Publicly funded resources, like; gene banks, genomics initiatives, and data sharing platforms are revolutionising cowpea improvement. Playing a part in many improvement efforts is the IITA Genetic Resource Center whose aim to conserve and distribute diverse cowpea accessions for research purposes. Genomic resources, such as the cowpea [reference genome sequence](#), the Cowpea iSelect Consortium Array, and mapping populations, like the MAGIC, are unlocking our understanding of the genetic basis of traits<sup>12</sup>. An awareness of the genetic basis for desired traits and affordable SNP genotyping is making marker-assisted breeding possible, even for small remote breeding programmes.

The era of big data has arrived for cowpea breeding, along with the need to archive, query, and share data. Institutes, like IITA, and other international collaborations are using the Breeding Management System to record and share cowpea breeding data in a unified format. Continued characterisation of cowpea diversity and knowledge sharing are critical to fully harnessing available genetic diversity and maximising cowpea genetic gain for food security. ■

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# Transformative research on cowpea: "STOPCALLOSOBRUCHUS!" – Post-harvest protection for smallholder cowpea production using vegetable oil

Louis E. N. Jackai, PhD, Professor and IPM Specialist and Dr. Beatrice N. Dingha, Associate Research Professor at the Department of Natural Resources and Environmental Design share with us their thoughts on post-harvest protection for smallholder cowpea production using vegetable oil, "STOPCALLOSOBRUCHUS!"

Cowpea is one of the most diverse, versatile and economically important indigenous legume crops in the world. Cowpea is of vital importance to the livelihood of millions of people in the developing world, as well as in the southern U.S. where it is grown mainly by small urban and rural growers for food, income and as a summer cover crop. It enriches (feeds) the soil with nitrogen for use by the next crop, and in the Southeastern U.S. cowpea is commonly consumed as a green, frozen or canned bean, but more widely as a "Crowder" or "Blackeye" pea sold in many grocery stores across the nation.

In our recent publications (Jackai et al., 2017, 2018), we present cowpea in its historical perspective, nutritional and health value to humans and livestock, as well as its vulnerability to pests and diseases. Trap cropping was featured as a potential non-chemical approach for controlling the invasive Brown marmorated stink bug, *Halyomorpha halys* (Stal). Cowpea has great potential as an all-round crop for a wide range of environments. Its attributes as a versatile crop are greatly limited and diminished by a number of biotic stresses among which insect pests, weeds and diseases are clearly among

the most challenging (see review by Kumar and Kalita, 2017).

This paper in the series focuses on post-harvest protection, which we consider the most critical mitigating factor in the alleviation of food security, especially in developing countries in Africa, Asia and South/Central America which depend heavily on legumes (especially cowpea) as a source of high protein for humans and livestock and as a source of family income. Post harvest losses of cowpea typically exceed 45% worldwide.

## Post-harvest losses in cowpea

The title of this paper sounds a clarion call to a lingering pest problem that has placed the realisation of the full benefits of cowpea in a state of limbo for longer than anyone could have imagined. This is most surprising especially given all the years of research and hundreds of publications on the subject at both ends of the sophistication continuum, by highly respected scholars and those not so distinguished.

So we ask ourselves what has gone wrong after all the years of intense investigation? The truth is that if we discount the use of synthetic insecti-

cides, nothing spectacular has been accomplished in the sense that the problem persists. Many estimates of the losses from storage are underestimates, especially in traditional spaces (Kumar and Kalita, 2017). Have we focused too much on the sophisticated and played down the seemingly mundane that is usually regarded as "indigenous" knowledge (IK) and, therefore, without enough scientific merit to be useful?

That notwithstanding, a recent grain and seed storage protection technology has been deployed in West Africa with promising results. It uses hermetic storage that employs triple layer bags, a technique referred to as the "Purdue Improved Crop Storage" or PICS (Baributsa et al., 2010; Baoua et al, 2015; Murdoch et al, 2012) has the effect of reducing oxygen levels in sealed bags from 21% to 18% after almost seven months of storage. The technology followed closely behind earlier research on solarisation from the same Purdue University laboratory (Ntougkam et al., 1997) that was a scientific spin-off from a common practice by cowpea farmers in Northern Cameroon, in West Africa. This is a good indication that IK can lead to important scientific developments. The

PICS technique uses two high-density polyethylene liners (80 µm thick) woven into a polypropylene bag; however, these bags are not so secure as to be guaranteed from being pierced by sharp objects or rodents during transportation, or storage, in the supply chain. Should this happen, the entire PICS operation will be compromised. It is therefore important to build, or stack, other control measures around this concept; the work we report here using vegetable oils is an important step in this direction.

## Plant oils provide lasting protection

The use of both edible vegetable and essential plant oils for the control of storage pests of legumes and grains is not a new concept, but despite many years of dedicated research on this topic, a consistent protocol for the use of oils has not been put forward. Many oils are known to be effective but the rates used and the results reported are as different as the number of reporting workers. Our understanding of how and why these oils (vegetable and essential oils) work is still somewhat vague, and only a few workers have attempted to delve into the intricacies of the underlying mechanisms.

In this report, we do not try to resolve all outstanding questions; rather we hope to advance the scientific thought on which oils work best and for what target, the concentrations required for efficacy, as well as the need to understand the science on how they work on *C. maculatus*. Knowing the structure of an effective oil is also important because it represents a biochemical signature or marker whose footprints can be searched for in the libraries of hundreds of plant oils worldwide to find the best oils for the purpose of protecting commodities in storage. It is

our belief that our discussion of this subject will establish a trajectory for scaling the use of oils in the control of other insects on legumes and other grain crops.

The most important pest, of stored cowpea, from a global distribution perspective, is the so-called “cowpea weevil” which is not a weevil (does not have a snout) but a beetle in the family Bruchidae, Order Coleoptera (the beetles). In this paper, we sometimes refer to this insect, *Callosobruchus maculatus* (Fab.), by the abbreviated form, “Cmac”. The clarion call in the title to “STOPCALLOSOBRUCHUS” is patterned after a similar name coined by the group seeking to control the invasive brown marmorated stink bug, *H. halys* in the U.S. using the mantra “[StopBMSB.org](http://StopBMSB.org)”.

Most cowpea farmers are low-to-medium smallholders who are generally also limited resource growers with low income. It is therefore important for scientists target these growers with technology that is well within their grasp, both from a financial, as well as a technological standpoint. The PICS technology is an excellent example of this approach, judging from reports on its adoption (Kumar and Kalita, 2017). Vegetable oils and other cultural (IK-driven) approaches, such as the use of wood ash, various condiments (e.g. hot peppers – *Cap-sicum* spp.) and natural products, such as neem (*Azadirachta indica*) leaf powders and various biorational insecticides) should be deployed as toolbox components built around the nexus of plant resistance. These in conjunction with hermetic storage will, in our opinion, comprise the most reliable platform for a framework in the sustainable management of this pest. The discussion that follows on use of vegetable oils should be seen as a

component of this collective (tactics in the toolbox) that constitute a veritable attempt to provide growers and the entire cowpea value chain with a reliable and durable IPM strategy for storage beetle control.

## Enhancing storage protection technology using plant oils

Both essential oils (Nenaah et al, 2015; Akami et al., 2017) and the common edible vegetable oils (Kumar and Kalita, 2007) have been reported to be effective in the control of Cmac. In studies conducted in our laboratory, we evaluated eight commonly available edible vegetable oils (including garlic, soybean, peanut, sunflower, coconut, truffle, corn and olive oil) in Greensboro, North Carolina, against Cmac on cowpea seeds for up to six month storage period in some experiments. The results were simply outstanding. We were interested in oils that would: a) cause high adult mortality to reduce egg-laying, and b) possess ovicidal activity or prevent/greatly reduce adult emergence (by increasing within-seed mortality).

While other parameters may also be important, we believe that these two are the most critical for reducing and eventually eliminating any recurrent infestation, even in the absence of hermetic storage conditions. This is relevant given the understanding that the infestation may actually begin from the field and become exacerbated in storage. Increasing oil concentration generally increased adult mortality (Figure 1). At the lowest rate (15µl/20 grams of seed), the less susceptible Mississippi Silver cowpea variety showed a distinct difference between treated seed and the untreated control, unlike in the highly susceptible Pinkeye Purple Hull cowpea variety.

So, varieties behave differently according

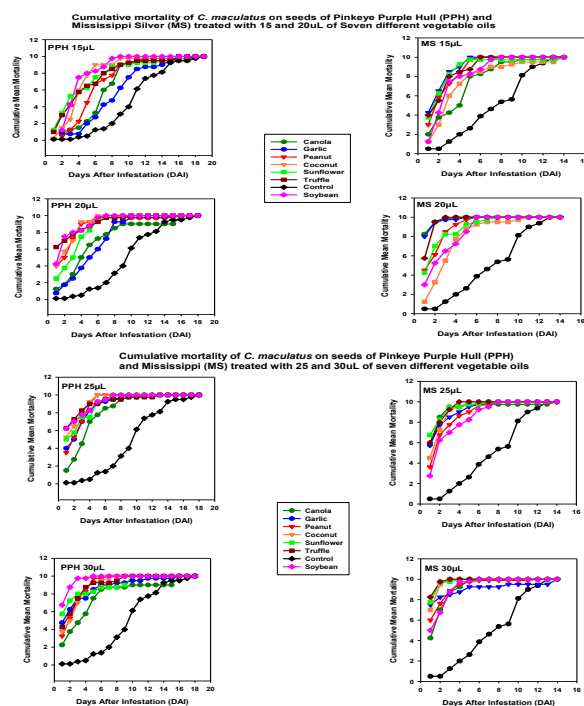


Figure 1: Cumulative mortality of adult *C. maculatus* on cowpea seed (var. Pinkeye Purple Hull) treated with different concentrations of seven edible vegetable oils over a 2-week period.

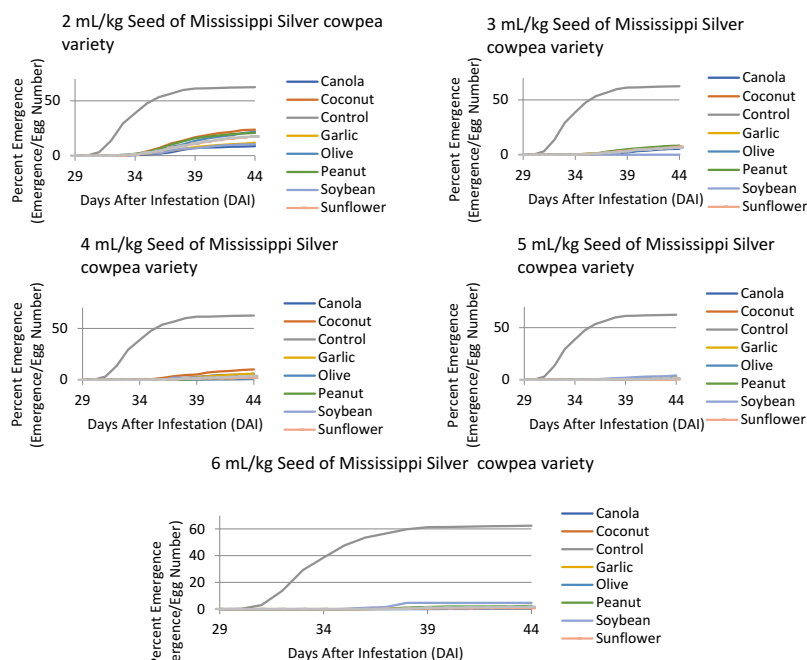


Figure 2: Cumulative percent adult *C. maculatus* emergence on cowpea seed (var. Mississippi Silver) treated with different concentrations of seven edible vegetable oils and an untreated control over 44 days.

to their resistance status. With a higher number of adults dying, fewer eggs were laid and subsequently, even fewer adults were recruited into the next generation as indicated by the adult emergence levels (Figure 2). All the oils tested had a pronounced effect on adult emergence which increased with oil concentration.

In long-term studies, it is clear that oils alone could protect cowpea from *Cmac* damage. Obvious differences in the level of protection among the oils are observable among different oils.

One of the main bottlenecks to the adoption of vegetable oils in cowpea storage protection is the lack of consistency in their use. This is thought to be a result of poor coverage (coating of seeds or grain) when larger quantities have to be protected. There are two parts to a possible solution: a) having an appropriate carrier for the oils, and b) development of a simple but effective

application process that would coat each grain/seed evenly. In studies carried out by Jackai and Dingha at NCA&T to improve coating, two essential oils (peppermint and lavender) and two edible vegetable oils (garlic and sunflower) were dissolved in ethanol to enhance coating. The results indicate that both the seed coating and biological effects of the oils were greatly improved by dilution in ethanol within 3 days (Figure 3). This process has obvious practical implications for seed/grain protection.

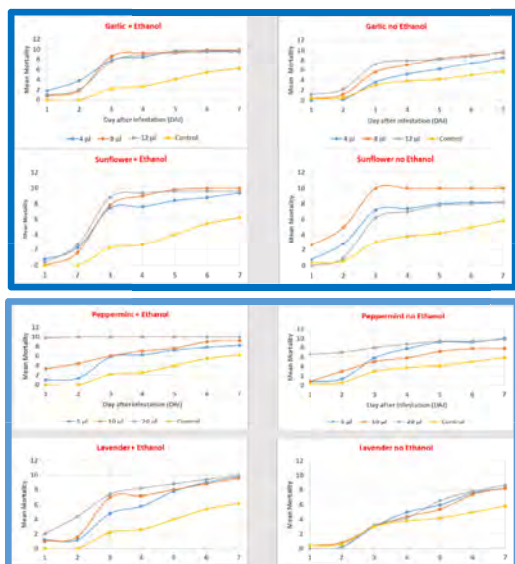
Regarding the coating process, the entomologists and biological engineers at N. Carolina A&T State University have developed a blueprint of a system that will uniformly coat each seed with a pre-determined amount of oil. Further testing is planned to determine various metrics on several biological variables in storage pest control, including persistence and shelf-life of various oils. Figures 1-4

show clearly that a range of oils can be very effective in long-term adult beetle suppression. We also know that some oils are persistent and remain effective for up to six months thus preventing, or greatly reducing, recruitment of new adults; eggs that were laid obviously did not survive (see Figure 4).

## The Toolbox model for future grain storage protection for small growers

The PICS technique is by no means the first case of hermetic approach in storage protection; there have been many reports on this approach (Kumar and Kalila, 2017). The PICS technology has greatly improved the process and taken it to a different level of triple protection. But while this may be seen by some as a nexus for building a long-term, sustainable storage protection for small growers, others (including the current authors) would prefer to use cowpea resis-





**Figure 3:** Cumulative adult *C. maculatus* mortality after seven days on cowpea seed (var. Mississippi Silver) treated with edible vegetable (top) and essential oils (bottom) diluted in ethanol. Control was treated with ethanol only.



**Figure 4:** Seed damage and emerged *C. maculatus* adults on cowpea (var. Pinkeye Purple Hull) without oil treatment (left) after 6 months storage. No damage or emerged adults on cowpea treated with canola oil (right).

tance as the flagship around which to build the future scaffolding to protect legumes and other grains in storage.

Other controls (tools in the toolbox) can be built around, or anchored to, this core. Resistant varieties generally require less oil protection than do susceptible ones. This same phenomenon occurs with synthetic and biorational insecticides in the protection of field crops. Stacking resistance and oil with PICS will be a winner anywhere, any day. Relying on any single tool in the IPM toolbox is risky for the reasons outlined earlier, no matter how safe and secure the tactic looks.

The tools in this IPM toolbox should include the use of biorational insecticides such as diflubenzuron which is reported to be very effective on Cmac (Kemabonta et al., 2010), use of various plant oils (especially the more accessible and less expensive, safer and equally effective vegetable oils), in conjunction with hermetic storage on a plant resistance platform. This would be equivalent to stacking

of genes except with a different activity span and a more diverse application scope as advocated by the tenets of IPM.

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# Improving the impact and visibility of plant science in Europe

Improving the impact and visibility of plant science in Europe, the aim of the European Plant Science Organisation is explored here plus an interesting example of research in the field, chlorosis that concerns the yellowing of the leaves

In essence, the European Plant Science Organisation (EPSO) is an independent academic organisation that represents no less than 220 research institutes, departments and universities from 31 countries across Europe and beyond. The organisation's aim is to improve the impact and visibility of plant science in Europe. As such, their highest priorities are to foster an understanding of plant science, to increase funding for basic research and to coordinate research activities at the national and European levels – and further afield.

It's worth looking at something of EPSO's history, certainly, we know that they were formed in 2000 for the purpose of promoting plant science at the European level. During the years that have since passed, EPSO has discussed recommendations on European and global science policy with high-level individuals and institutions, namely national politicians, Members of the European Parliament and the European Commission.

## Funding and cooperation in plant science

Ensuring that appropriate funding, in terms of content and critical mass for plant research as part of the European Commission's Horizon 2020, is very important to EPSO. Back in 2004, EPSO along with EuropaBio began one of the first European Technology Platforms 'Plants for the Future' (Plant ETP). In 2007, the platform presented their vision of plant research for the next 20 years, the Strategic Research Agenda, which identified the challenges for Europe's society and economy to which the plant sector can contribute

Plant ETP, today, consists of the European Seed Association (ESA) and individual companies from industries, EPSO representing academia, as well as Copa-Cogeca (the united voice of farmers and agri-cooperatives in the EU) bringing in the farming communities. Together,

they develop action plans on research, innovation and on education, as well as working at the European and national levels to advocate internationally competitive research and innovation.

## Outreach

One thing worth mentioning is that the EPSO is promoting is the Fascination of Plants Day on 18th May 2019, the aim of which is to get as many people as possible across the globe fascinated by plants and enthused about the importance of plant science in sustainability producing food, for agriculture, plus for forestry, horticulture and all of the non-food products like paper, timber, chemicals and energy.

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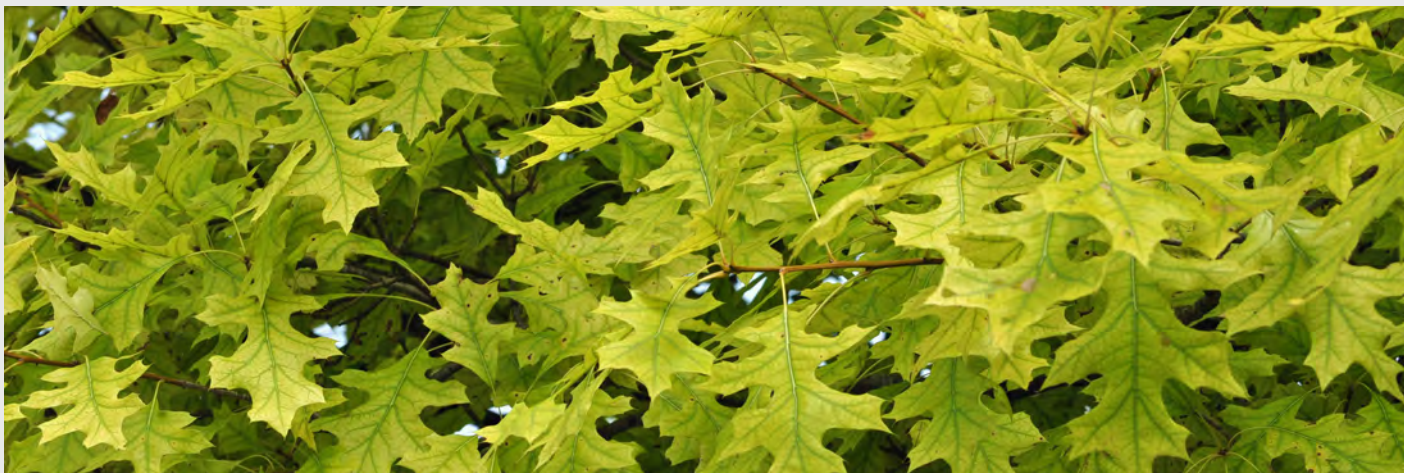
**"In essence, the European Plant Science Organisation (EPSO) is an independent academic organisation that represents no less than 220 research institutes, departments and universities from 31 countries across Europe and beyond."**

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## The future of planet science: Collaboration

Having looked at just some of the EPSO's work, it's just worth saying in closing that EPSO has one NGO, two European industrial organisations and individual companies, who are observers. EPSO collaborates with ten national learned societies in plant biology, along with other European science organisations in the Initiative for Science in Europe (ISE) and plant science organisations worldwide in the Global Plant Council (GPC).

Also, since 2011, EPSO has worked with the Food and Agriculture Organization of the United Nations (FAO) and African scientists towards longer-term partnerships in plant science that promote sustainable agriculture in developing countries. Every two years, scientists from Europe and other continents get together to present



## Chlorosis – what you need to know

As an example of the many aspects of plant science, let's just focus on one, which is called chlorosis. According to The Royal Horticultural Society (RHS) in the UK, chlorosis can be described as the yellowing of the leaves of plants. In their view, you are most likely to come across the term chlorosis in descriptions of nutrient deficiencies or plant viruses, but it is worth bearing in mind that there are many more possible causes of chlorosis other than viruses or nutrient problems.

Chlorosis is a very common symptom of virus infection in plants, according to the RHS. Some common viruses that can affect garden plants are: Camellia yellow mottle virus; Cucumber mosaic virus; Daffodil viruses; Impatiens necrotic spot virus/Tomato spotted wilt virus; Pelargonium viruses; Raspberry viruses; Sweetpea viruses; Tomato viruses and; Tulip viruses.

We also know that chlorosis is often accompanied by other symptoms that provide additional clues about the cause, such as leaf fall, wilting, dieback and stunting. In addition, it is known that the yellowing of the areas between the veins (interveinal chlorosis) normally indicates the nutritional problem of manganese, iron or magnesium deficiency. Added to this, iron deficiency impacts the youngest leaves first, but the symptoms of manganese and magnesium deficiency usually begin in the older leaves, the RHS tell us.

Added to this, it is worth considering that nitrogen deficiency causes a more general yellowing or reddening, usually with the older leaves first, frequently accompanied by a lack of vigour. In terms of potassium deficiency, the yellowing is often more pronounced at the leaf edges according to the RHS.

Finally, leaf yellowing can occur under waterlogged conditions or when the soil is too compact. Drought conditions can lead to chlorosis, followed by browning and leaf loss. Cold-induced chlorosis is common in spring on young, actively-growing leaves, and examples of plants that may display this are pieris, magnolia and skimmia. We also know that pests that attack the foliage or roots of plants which can cause leaf yellowing, such as aphids, whiteflies and red spider mites. <https://www.rhs.org.uk/advice/profile?pid=772>

and discuss cutting-edge science at EPSO's conference. Perhaps then the success of plant science in the future will be helped by collaboration, of which we have looked at a number of good examples where such work is taking place. ■

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# Plant nutrition: The design of efficient Fe-shuttles to prevent iron-deficiency chlorosis (IDC)

Maria da Conceição Rangel, Associate Professor at ICBAS\_University of Porto and REQUIMTE-LAQV details an aspect of plant nutrition that concerns the design of efficient Fe-shuttles to prevent iron-deficiency chlorosis (IDC)

Iron (Fe) is one of the most abundant elements in Earth's crust, and the most abundant transition metal, being an essential micronutrient for all living organisms, with the exceptions of *Lactobacilli* and *Borrelia burgdorferi*. Despite its abundance, the geological availability of Fe is compromised by the fact that the element exists in insoluble chemical forms making its uptake extremely difficult to living organisms. Bacteria and plants obtain iron from the environment by chelation, whereby the element is chemically bound to another substance making the whole complex (Fe-chelate) soluble and available. Chelation is the chemical tool used by living organisms for metal ion absorption, transport, storage and biological function and a judicious choice of a chelator allows tuning physicochemical properties of the metal ion chelate.

The absence of a proper amount of Fe puts plants health at risk since such lack has implications in several functions namely the biosynthesis of chlorophyll. Iron deficiency chlorosis (IDC) is a severe condition in which Fe-deficient plants develop yellowing of the younger trifoliate leaves, reduced leaf areas and shoot and root dry weight leading to reduced crop's yield and serious economic losses.

The problems raised by low iron availability are reflected not only in plant's growth but also in the Fe content of the seeds and fruits. Consequently, this problem affects animal nutrition and health since vegetables, cereals and fruits are common sources of the element. Plants represent a huge part of the human diet and in certain regions account for up to 80% of the daily Fe intake. This makes healthy plants with the appropriate concentrations of Fe an important health issue because iron-deficient diets are a significant contributor to iron deficiency anaemia, a disorder that affects large numbers of the population in both the developed and developing world.

In addition, livestock rations are also mostly comprised of plant material we produce. Thus, the cultivation of cereals, vegetables and fruits with better nutritional properties will have an enormous impact on human health. The successful cultivation of crops with the finest nutritional properties is an issue of paramount importance in agriculture and health and consequently determinant for a sustainable development.



Iron deficiency chlorosis is particularly severe in alkaline soils, which constitute approximately 30% of the world's arable land. Consequently, farmers must rely on supplementing their crops with iron to avoid serious growth deficiencies and disorders, such as IDC. Soil or foliar application of synthetic Fe-chelates is one of the common measures to correct IDC. Fe-chelates derived from polyaminocarboxylic acids, namely Fe-EDTA and Fe-EDDHA, are the available commercial products used in an agricultural context and some drawbacks have already been reported in this respect. The limited number of distinct Fe chelates that are used as fertilizers calls for the identification of new ligands capable of producing Fe-complexes with properties that allow more efficient pathways for root uptake,

root to shoot translocation and the maintenance of metal homeostasis.

The long-term objective of the project is to design better (Fe)rrying vehicles to shuttle iron into plants and to understand how these new Fe shuttles work in *planta*. To achieve this purpose, research is developed following three main vectors:

- Design of Fe-chelates;
- Evaluation of Fe-chelate efficiency in a model plant soybean (*Glycine max* L.) and;
- Investigation of the mechanisms of uptake and root-to-shoot translocation of the Fe-chelates at a physiological, biochemical and molecular level.

The innovation and key idea of this proposal is the formulation of Fe-chelates based on a distinctive family of chelators that permits the design of compounds with a variety of chemical properties that can be fine-tuned according to the results obtained on the evaluation of their biological properties. Such a possibility allows not only the improving of the performance of the fertilizer but also the investigation of the mechanisms underlying their activity.

In the first study regarding the hydroponic growth of soybean (*Glycine max* L.), we tested a new family of Fe-chelates and found that they have great potential as new IDC correctors since plants were significantly greener and had increased biomass when compared to plants supplied with the commercial fertilizers. In particular, plants supplied with one of the compounds were able to translocate more iron from the roots to the shoots. Moreover, the feedback from



the study already inspired the modification of the chelator's structures and new ones are currently on trial.

Having identified one lead compound that shows very promising characteristics we will proceed to: (a) an understanding of which physicochemical properties are crucial; (b) the establishment of structure-activity relationships and (c) an investigation into the mechanisms of uptake and root-to-shoot translocation of the Fe-chelates at a physiological, biochemical and molecular level.

In a recent pilot study performed in artificial soil, the lead compound was compared with the commercially available fertilizer and, the compound also revealed to be advantageous in such conditions.

The PI of the project<sup>1</sup>, Maria Rangel, is a Bioinorganic Chemist whose lab focuses on designing molecules that can bind and deliver metal ions to address biomedical and environmental issues. During the past decade, there has been a particular interest in the design of iron chelators to address infection and iron overload disorders. The evolution of the field of plant nutrition seemed quite challenging within the Fe biology area. The Co-PI, Marta Vasconcelos heads the PlanTech group and is devoted to the fields of plant nutrition and plant physiology with the major goal of reducing human malnutrition.

The multidisciplinary and complementary research team is composed by 14 members working in two research units LAQV@REQUIMTE (University of Porto) and CBQF@ESB-UCP (Portuguese Catholic University).

A strong collaboration between the fields of bioinorganic chemistry and plant biology is not so often visible and has been very enriching and a big success. The two research groups had not interacted before and learned a lot from each other. Quite a few young scientists and students became very interested in this topic, and have joined the team to work as PhD students and project trainees.

<sup>1</sup> FERPLANT (PTDC/AGR-PRO/3515/2014 - POCI-01-0145-FEDER-016599)



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# 10 security tips to reduce empty nest stress

Justin Freeman, Technical Manager of the Master Locksmiths Association, offers expert advice to ensure that thieves walk away empty-handed from your property

**E**mpy properties can present a potential thief with an unmissable opportunity; if a homeowner is perhaps working abroad or on holiday for a few months there are tell-tale signs of an uninhabited home that a thief will look for – and look to exploit.

Even if you are in the process of seeking a new buyer or tenant for your property and it is empty, the threat is still present; just because a home is without inhabitants does not mean it is devoid of value, and thieves may potentially seek to ransack a house to find anything they can profit from. The advice detailed below will help to ensure that thieves walk away empty-handed from your property.

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**“Would-be thieves don’t always need to force their way into your property. Workmen, letting agents and past tenants may still have keys to your property. Even if you ask for all the keys to be returned, there’s no guarantee that they don’t have copies.”**

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## **Check all doors and windows, including garage doors and rear entrances, and make sure they are in good condition**

Make sure to check for broken window frames, rusty locks or damaged garden gates – signs of neglect act like red flags to potential thieves, whilst also presenting an easy point of entry. A local MLA-approved locksmith will be able to check that your locks meet insurance requirements and upgrade them if needed.

## **Don’t forget about the outside of your property**

Make sure to cut back large or overgrown plants that provide cover and keep wheelie bins and other large objects away from walls and fences, where they can be used as footholds to help thieves to enter. The noise of crunchy gravel can be a great deterrent too. Meanwhile,

spikey plants, such as berberis, pyracantha or holly bushes, will make it harder for thieves to gain access. Make sure that your garden is – or at least looks – regularly maintained. Overgrown grass, plants and borders are an easy tell, so think about planting low maintenance plants – or employing a gardener. Finally, to keep intruders out, make sure gates and outbuildings are securely locked with Sold Secure locks or chains.

## **Install an alarm and consider using a remotely-monitored CCTV system**

This will allow you to keep an eye on your property using your laptop, tablet or smartphone, from anywhere in the world. As well as alerting you to issues, alarms and security systems can also act as a good visual deterrent. Homes with a security system are 300% less likely to be burgled.<sup>1</sup>

## **Make neighbours aware that your property is empty**

Consider leaving a spare key with a trusted neighbour and asking them to pop in a couple of times a week to check your property. You could even ask if they want to park their car on your drive, which will give the impression that someone is in. It may also create good relations, which means they are more inclined to keep a vigilant eye on your property.

Also, consider asking them to stop newspapers and post from building up in your porch or hall. A sizeable pile of local newspapers and circulars underneath your letterbox is a sure sign that the property is long-term vacant – or that no-one visits regularly.

## **Know who has access to your property**

Would-be thieves don’t always need to force their way into your property. Workmen, letting agents and past tenants may still have keys to your property. Even if you





ask for all the keys to be returned, there's no guarantee that they don't have copies. A patented lock system is a simple, cost-effective way to limit the number of keys in circulation and prevent keys from being cut without proof of ownership.

### **Install preventative measures**

Dusk-till-dawn security lights around the property will help deter thieves from attempting to gain access whilst alerting your neighbours at the same time of any unusual activity. Timer lighting systems inside your property are simple to use and create the impression that someone is home. Fake televisions also work on a timer and emit multi-coloured LED lights, just like a real television. But make sure that a fake TV is used upstairs, where burglars can't see that it's not real.

### **Invest in good-quality security fixtures**

Quality locks and security measures not only reduce the likelihood of theft, the increased lifespan of the products will also save money in the long term. For a list of rigorously tested security products, visit [www.soldsecure.com](http://www.soldsecure.com).

### **Don't be tempted to DIY**

If you have concerns about the security of your property, hire a professional - the average cost of fixing botched DIY jobs is £323. Your local MLA-approved locksmith will be able to provide a thorough and independent safety and security assessment, offering advice and installation services on all security upgrades necessary to meet insurance requirements.

### **Out of sight, out of mind**

Drawing the curtains or blinds seems like an obvious way to make sure no one looking in can tell the property is vacant. However, it's also a giveaway if every window in your house is covered by curtains or blinds; consider leaving the upstairs windows uncovered, which will also allow the light from any fake TV's to be seen more easily.

### **If you aren't sure, consult**

If you aren't convinced that your house is secure or that you've done enough to deter thieves, contact [an MLA-approved locksmith](#). A locksmith can conduct a site survey to ensure that your house is as protected as it can be and that you have peace of mind when leaving your property vacant. ■

#### **References**

1 Home Security Month, 2017 (Yale). Home Security Month, <http://www.homesecuritymonth.com/may-day-infographic-ins-outs-diy-3/>

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# Security: Protecting public spaces with pedestrianisation

Gavin Hepburn, Director at ATG Access shares his expert perspective on the importance of security in terms of protecting public spaces with pedestrianisation

Over the past couple of years, we've seen a sharp rise in vehicle-ramming attacks across the world, with many of these taking place throughout Europe.

Hostile vehicles are becoming the weapon of choice for terrorists – they're easy to obtain, they can inflict large amounts of damage in a short space of time and, unlike explosive devices, they require little skill to operate.

While these incidents should not disrupt our way of life, serious consideration and action must be taken to ensure that the public is as protected as possible from future terror attacks.

One effective security solution is pedestrianisation – closing off streets with high footfall to vehicles. And with the news that London Mayor Sadiq Khan has ordered a feasibility study into the pedestrianisation of areas of Parliament Square following the suspected terror attempt of August 2018, should more cities and towns be looking to follow suit?

## Multifunctional cities

In recent years, the 'traditional' high street has undergone something of a revolution, with many cities and town centres transformed into bustling multi-functional spaces, hosting a wide variety of events, from local farmer's markets and marathons to major cultural events.

Public events provide a boost to the local economy and are a great way to bring together communities. However, this increased footfall also brings greater security concerns, as attacks often take place at tourist attractions where there is a large crowd of people, such as Christmas markets – take the Berlin attacks in 2016 as an example.

Therefore, it's becoming incredibly important to protect the perimeter of such locations to deter and prevent hostile vehicles from trying to make contact with potential targets.

If people don't feel safe at events, they may choose not to attend – our recent [research](#) found that 29% of Brits would choose not to go to a public event due to concerns around low levels of security – and this could prevent cities and towns from developing into truly multifunctional spaces that can be used by all. But this is where pedestrianisation can help.

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**“One effective security solution is pedestrianisation – closing off streets with high footfall to vehicles. And with the news that London Mayor Sadiq Khan has ordered a feasibility study into the pedestrianisation of areas of Parliament Square following the suspected terror attempt of August 2018, should more cities and towns be looking to follow suit?”**

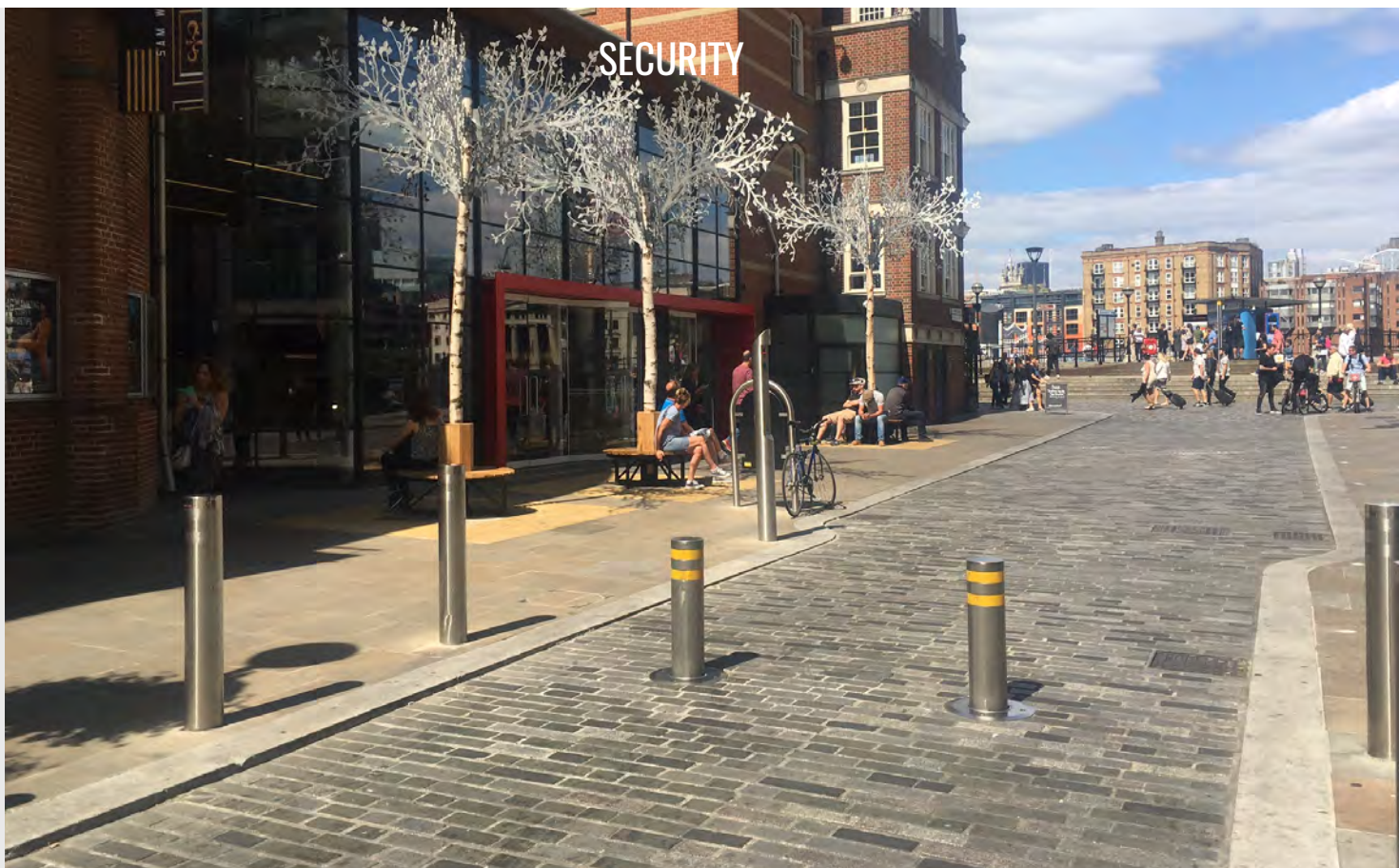
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## Protecting the perimeter

In its simplest terms, pedestrianisation is the limiting, or removal, of vehicular traffic from zones of cities or towns. It can provide better accessibility and mobility for pedestrians, improve the aesthetics of the area, reduce air pollution and importantly, improve public safety. It's achieved through a range of urban design techniques, such as the removal of curbs and pavements, and the addition of street furniture and bollards to enforce the segregation of vehicles and pedestrians allowing free movement.

As well as aiding pedestrianisation, erecting strong, sturdy barriers or bollards around public spaces is one of the most effective methods of preventing vehicles travelling at high speed from colliding with





pedestrians or indeed, even accidental vehicular impacts with pedestrians.

These solutions can either be automatic, so they rise from the ground and are hidden when not in use, fixed or removable depending on the area's perimeter design and requirements. Bollards can also be dropped if needed for an emergency service vehicle access or even operated using a timing clock to zone off areas of a city during specific, pre-determined times.

When choosing a barrier or bollard solution, consideration should be given to how they will fit in with the design and structure of a particular area. While barriers provide protection, sometimes their size or aesthetic appearance can make the public feel uncomfortable, with their presence serving as a reminder of current threat levels.

Towns and cities need to remain functional and attractive to the communities that use them. Therefore, security measures must be able to offer enhanced safety, without compromising on aesthetics. They should avoid creating a 'fortress' mentality and be appealing and functional enough to ensure the public feel comfortable to carry on life as normal.

Security systems do not need to be an eyesore to be effective – they can be specifically designed to subtly

blend in with their surroundings. Arsenal's Emirates Stadium, for example, has installed large concrete letters spelling out the word 'Arsenal' at the stadium's main entrance, which act as a barrier to vehicles and blend into the stadium design at the same time. Meanwhile, cities such as New York, Barcelona and Oslo have opted to use unobtrusive barriers such as trees, flower pots, planters, street furniture and water features, making their spaces safer whilst also being aesthetically pleasing.

With vehicles increasingly becoming the new weapon of choice for terrorists, we need robust security measures. Terrorist incidents are hard to predict and intercept, but it's vital that governments and city councils effectively mitigate these threats with measures such as pedestrianisation to ensure that our cities and towns can continue to be safe, multifunctional and diverse. ■

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# Digitalisation: The key to maximising human potential

Ildar Uysumbayev, Head of the Department of Public Services of the Agency for Civil Service and Anti-Corruption of the Republic of Kazakhstan argues that digitalisation is the key to maximising human potential as we journey towards 2050

The last decade has been a defining period for human development. Technological advances mean that more people than ever before are connected across the globe in ways that previous generations would scarcely have believed was possible.

There are few countries which have felt the effects of digitalisation as acutely as Kazakhstan. Being the size of Western Europe and the largest landlocked country in the world, it provides an essential means of reaching our citizens, wherever they may live. In the wake of the digital revolution, technologies such as mobile banking, big data and blockchain have allowed people in every corner of the country to enhance their lives, creating new opportunities for prosperity and growth.

In recognition of the defining role that digitalisation continues to play, President Nursultan Nazarbayev has made transitioning to a full digital society a national priority. Of course, Kazakhstan's geographical scale makes developing our digital infrastructure a complex and challenging task – but it remains an essential process.

This digital transformation is enhanced by what some describe as the 'Digital Silk Road'. It is an ambitious programme of technological investment which runs from Europe to Asia and will complement the physical transport routes which are also being developed. It will provide crucial investment in revolutionary digital fields including artificial intelligence (AI), cloud computing, nanotechnology and internet security.

Such investment will help connect businesses and homes across our vast country to fast and reliable digital technologies. This process represents a revolutionary way to empower innovative start-ups to create, foster

and develop solutions that meet the challenges of the global economy.

As a country that has long benefitted from its large mineral reserves, Kazakhstan's economy is now fundamentally transforming thanks to digital technologies. Digitally-driven organisations such as the Astana International Financial Centre, and the International Centre for Green Technologies, are now at the forefront of their respective industries in Eurasia. This would have been unimaginable even a decade ago.

At a national level, governments can no longer just be policymakers. Instead, we need to be digital market makers, providing businesses, organisations and individuals with the tools they need to compete in a globalised world. This is why our government has placed a clear focus on fostering and supporting our domestic market with the establishment of the International IT Start-Up Hub in Astana.

Rapidly developing economies have long understood the need to embrace change. This is certainly true of Kazakhstan, where public and private sector organisations have developed agile, digital-first solutions which meet the needs of a globalised marketplace. For example, banks, government departments, retailers, energy suppliers and airlines have all developed digital platforms with innovative user interfaces which promote better consumer engagement, saving time and ultimately money.

At the same time, instances of corruption remain a challenge for many societies. Some individuals abuse their positions of trust for personal gain, often at the expense of the average citizen. This severely under-



mined the public's trust in national institutions. The digital revolution is at the forefront of efforts to ensure that justice prevails.

Kazakhstan is working hard to eradicate this socially-destructive practice with the help of new technologies. Digitalisation not only helps to promote a level playing field for all citizens and businesses but also streamlines many technical and bureaucratic processes.

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**“There are few countries which have felt the effects of digitalisation as acutely as Kazakhstan. Being the size of Western Europe and the largest landlocked country in the world, it provides an essential means of reaching our citizens, wherever they may live.”**

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Ultimately, it makes decision-makers more accountable and the decision-making process more transparent. Currently, almost 80% of government services in Kazakhstan can now be accessed online. This significantly reduces the burden on the average citizen and helps to eliminate corrupt acts.

The new digital age has brought many opportunities, but these benefits have not always been enjoyed

equally. Many citizens working in highly-mechanised industries remain concerned about the effects of automation on their jobs. It is, therefore, important that we, as a government, prevent these workers being left behind by continuing to offer support through upskilling and educational programmes.

As Kazakhstan looks to 2050 and the realisation of our country's strategic vision, we must continue to embrace the changes brought about by digitalisation. However, we must ensure that we are focused not just on the technological developments, but also on the human side of this change. Focusing on human-led outcomes will be essential if we are to continue to create, adapt and innovate in a digital world. ■

**Ildar Uysumbayev**  
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# Angles on Agility: A CEO's View

John Mark Williams, the new CEO at the Agile Business Consortium, explores some of the key questions around agility and its value for the public sector.

John joined the global, not-for-profit Consortium in September this year as their new CEO. Here he offers his personal and candid perspective on some of the questions facing professionals responsible for change initiatives.

*“Traditional waterfall project management experience makes for a good foundation on which to layer agile knowledge and skills”*

- John Mark Williams

**Q. How would you describe business agility?**

**A.** Business agility is a competence required by all businesses in the future and is critical for the public sector. At its simplest, the purpose of business agility is to help us to be more confident in the face of the uncertainty that's surrounding us.

**Q. In your first few months as CEO, what have you found most surprising?**

**A.** As I've become immersed in this world of business agility, I've been really surprised about the degree of confusion I've found. People become very attached to their favourite flavour of agile and that in itself can damage agility, particularly where practices need to respond to each unique environment. I'm really encouraged that my peers, both inside and outside of this organisation, are absolutely committed to resolving this – for the good of the economy and society itself.

**Q. What is the difference between agile as a process and an agile mindset?**

**A.** Ultimately, it's difficult for processes to 'bed in' and be successful where an agile mindset isn't already in place. A process can be handed to someone to follow, but agile working cannot be sustained without the mindset that drives it forward; the constant focus on value, and always putting customer needs at the heart of decisions about public services.



John Mark Williams, CEO at Agile Business Consortium, has a career spanning 40 years, including being CEO for Gateway to London, and International Trade Director for UK Trade and Investment. John has worked with both central and local government bodies, responsible for inward investment promotion, international business, banking, and higher education. He is a Fellow of the Chartered Management Institute, a Fellow of the Institute of Commercial Managers, and a member of the Royal Overseas League..



**Q. When organisations are fully agile, do they still need projects and project management?**

**A.** Projects have an overwhelmingly positive purpose – to deliver outcomes.

Life is full of projects. All our endeavours have milestones and end points. Yet these don't undermine the concept of continuing and lifelong improvement. They simply give us opportunities to check on the outcomes we're aiming for.

An agile organisation will operate around continuing cycles of feedback and improvement, but that can still be effective within a project-led environment. Project managers are skilled at supporting the delivery of outcomes, and we need different outcomes at different times – and so we organise around projects.

Projects themselves may be defined as temporary endeavours, but their value is here to stay.

**Q. Where do PMOs fit in an organisation's journey to agility?**

**A.** Project Management Offices (PMOs) are in a unique position to support the cultural shift needed for public services to become adaptable and responsive to society's changing needs. PMOs can act as integrators and facilitators, asking the right questions and helping to create frameworks that embed agile ways of working.

PMOs have an important role to play in making agility happen.

**Q. What about project managers? How does their role change in an agile environment?**

**A.** An agile world has no place for the command and control structures that have been a part of traditional management. New ways are needed, and the introduction of agile principles gives project managers the chance to strengthen their skills in support of their teams and all their stakeholders.

Traditional project management experience makes for a good foundation on which to layer agile knowledge and skills. However, to be successful this will require a shift to an agile mindset.

***“Business agility is a competence required by all businesses in the future.”***

**- John Mark Williams**

## **The Agile Business Consortium**

in partnership with APMG-International, has developed a range of business agility qualifications. This includes AgilePM®, the world's leading certification in agile project management.

Achieving agility is not a single event but a journey. The purpose of the Agile Business Consortium is to support that journey by providing a range of resources and knowledge-sharing opportunities. We believe in transparency, and whilst members get privileged access and benefits, much of what we provide is publicly available and free.

Find out more about membership at [agilebusiness.org/membership](https://agilebusiness.org/membership)

**Q. Do project managers need to requalify to become agile?**

**A.** Business agility is a mindset and as such will develop over time if it is nurtured in the right way. Whilst qualifications are not by any means the sole root of agility, they are a valuable opportunity to become immersed in agile thinking, to encourage an agile mindset.

The Agile Business Consortium has developed a range of business agility qualifications in partnership with the accreditation and examination body APMG-International. This includes Agile Digital Services (AgileDS™), which is Agile project management tailored to the needs of the public sector. It is based on the UK Government's successful Digital Service Standard and includes written guidance, training and qualifications for people developing digital services.

Achieving agility is not a single event but a journey. The purpose of the Agile Business Consortium is to support that journey by providing a range of resources and knowledge-sharing opportunities. We believe in transparency, and whilst members get privileged access and benefits, much of what we provide is publicly available and free.

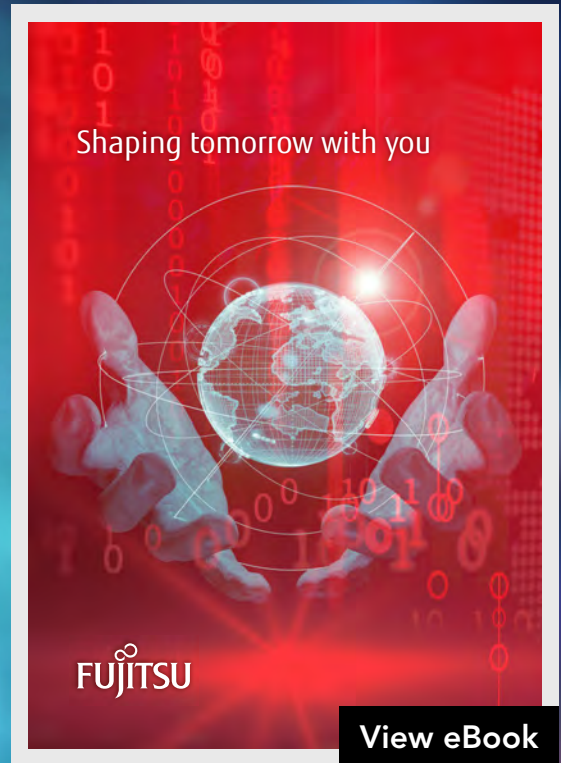
Leading, promoting and enabling business agility worldwide



The background is a vibrant, abstract digital composition. It features a central bright blue and white light burst that radiates outwards. Overlaid on this are various digital motifs: vertical columns of binary code (0s and 1s) in red and white, some of which are slightly blurred to create a sense of depth. There are also green 3D bar charts with thin lines connecting their tops, suggesting data trends. The overall color palette is dominated by blues, greens, and reds, with a high-tech, futuristic feel.

FUJITSU





# Shaping tomorrow with you

Andrew Cowling at Fujitsu Scanners explains how local government can benefit from document management technology, as well as his thoughts on GDPR-compliance.



# Making Europe a world leader in information and communication technology (ICT)

Andrus Ansip has been Vice-President of the European Commission in charge of Digital Single Market since 2014 and here, we learn something of his ambition to make Europe a world leader in information and communication technology (ICT)

**A**ndrus Ansip has been Vice-President of the European Commission in charge of Digital Single Market since 2014.

Andrus Ansip, a former Prime Minister of Estonia, is responsible for leading the Commission's efforts to remove the regulatory barriers currently separating 28 national markets to help make Europe a world leader in information and communication technology. It is estimated that this could contribute as much as €415 billion to the European Union's (EU) economy and help create hundreds of thousands of new jobs.

The ambitions of the Digital Single Market go beyond Europe's borders to encouraging global cooperation on a digital future, from working together to advance international data economies and converging standards to keep the internet open through to fighting cyber risks and ensuring that data flows freely between regions, countries and continents.

In October 2018, Ansip told the Transatlantic Digital Economy conference organised by the American Chamber of Commerce to the EU: "We see data protection as a condition for stable, secure and competitive global commercial flows. We also see it as a fundamental right."

There have been concerns in the U.S. that the EU's General Data Protection Regulation (GDPR) could hinder commercial flows and innovation because of high compliance costs.

However, Ansip said, the EU set up a special communication channel with U.S. authorities about GDPR implementation to identify and resolve issues before they became major problems.

He added that while GDPR is new, there is a lot of continuity with previous EU rules, which had been in place for more than 20 years and have shaped EU-U.S. relations in data protection.

"In addition, many of the changes will actually help foreign operators – by cutting compliance costs as well as red tape," Ansip said.

"Take the one-stop-shop for foreign operators that are established in the EU and will deal with only one authority for all their processing operations in the EU."

## Cybersecurity

Data protection is just one branch of cybersecurity, something that is at the top of the EU's digital agenda.

In December 2018, Ansip addressed the Cyber Security Conference in Vienna outlining Europe's progress on cybersecurity and the need for a coordinated approach to tackling what is an ever-evolving threat.

"Last year, 80% of European companies fell victim to at least one cybersecurity incident. In some EU countries, half of all crimes committed are cybercrimes," he said.

"These attacks are booming as our societies and economies turn more digital, more dependent on the internet and global connectivity.

"They undermine trust in the digital economy and wider online environment. They cost the EU economy many hundreds of billions of euros. And they are increasingly combined with disinformation as a means to undermine our democracies.

"This is something no country can afford to ignore:

politically or economically.”

Hackers do not respect borders but the capacity of different EU countries to respond to attacks varies significantly.

As part of the Digital Single Market, the EU is working on legislation to bolster cybersecurity infrastructure and collective resilience.

“Europe needs to invest more in cyber as a matter of urgency. We are already pooling more EU and national funding for cybersecurity research, innovation and industrial activities,” Ansip said.

“Equally important is a strong commitment from each country to improve national cyber-readiness and capabilities... This is a primary objective of the Directive on security of network and information systems – the NIS Directive. We are slowly getting there.”

There is, however, still a long way to go – only 20 countries have fully implemented the directive

Elsewhere, the EU is pushing ahead with the Cybersecurity Act, which aims to create a certification for ICT products and services.

“This will strengthen trust and confidence in the online environment, hopefully beyond Europe as well. It will stimulate ‘security by design’ and make sure that these products and services are technically compatible between EU countries,” Ansip said.

To keep pace with advances in technology, the Commission has proposed more than €2 billion over the EU’s next long-term budget period to set up a network of cybersecurity competence centres.

## AI & robotics

Emerging technologies such as artificial intelligence (AI) are set to be a priority in 2019.

“Along with much-needed investment, especially in research and development, Europe places a focus on social, economic, ethical and legal issues,” Ansip told the Transatlantic Digital Economy conference.

“In the short term, we are working on ethical guidelines for AI that should be presented in spring 2019. We are also working with international experts to draw up a coordinated EU plan for AI development and deployment.”

The Commission has also long been aware of the growing importance of robotics, setting up the world’s largest civilian robotics programme – the public-private partnership for robotics in Europe (SPARC) – in 2013 with up to €700 million of EU funding for 2014-2020 bolstered by an extra €2.1 billion of industry investment.

But just as important as supporting the development of AI and robotics is ensuring the digitisation does not create “winners” and “losers”. The EU has several schemes to help people develop the right digital skills, as well as re-skilling and up-skilling.

“The evolving demand for digital skills in industry also requires companies to get involved. However, they do not always want to invest in training employees to keep up with new processes. I think this is an error. And the best companies do invest in their workers, heavily and systematically,” Ansip wrote in a 2017 blog.

“We should not be afraid of technology – or of new technologies. Together, we can make sure that they work for everyone.” ■

[https://ec.europa.eu/commission/commissioners/2014-2019/ansip\\_en](https://ec.europa.eu/commission/commissioners/2014-2019/ansip_en)

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# The future of robotics science, research and training for the 4th Industrial Revolution

Professor Samia Nefti-Meziani from The University of Salford provides a compelling insight into the future of robotics science, research and training for the 4th Industrial Revolution

One of the key concepts of the 4th Industrial Revolution is the idea of a 'smart factory', where physical systems such as production lines and robots communicate with each other, as well as humans, through the Internet of things (IoT) and are linked with cyber systems that can make simple decentralised decisions with a high level of autonomy. Human intervention is minimal and intuitive and where humans can benefit from help, robotic technologies can assist to make tasks both easier and safer. Such factories would be highly efficient and offer a competitive advantage.

Researchers devising more effective robotic technologies will, therefore, have a huge impact on manufacturing and other sectors in the near future. In smart factories, people will increasingly work alongside robots, will be able to customise assembly lines, and robotic technologies will assist us to be more productive in our jobs.

Preparing for this future scenario and ensuring that upcoming robotic technologies are both resilient and sustainable is a challenge for a new generation of scientists. The [SMART-E project \(Sustainable Manufacturing through Advanced Robotics Training in Europe\)](#) was set up to deliver world-class research and training programme

to support a new generation of roboticians who aspire to play central roles in the 4th Industrial Revolution.

## Addressing the emerging issues in robotics research

The research as part of the SMART-E project focused on emerging issues, such as embodied intelligence, verification and testing, interoperability, worker-support by cyber-physical systems, autonomous de-localised decision making, plus practical business considerations such as ensuring that new manufacturing processes are resilient, sustainable and cost-effective.

The scientific focus of the project was divided into three main areas, which when combined, covered the concepts relevant to the majority of emerging robotic technologies we expect in Industry 4.0.

## Dexterous, soft and compliant robotics in manufacturing

This area of research focused on 'mechanically intelligent' machines, which adapt and are able to manipulate soft and hard, as well as light and heavy objects, with variable stiffness and dexterous motion in changing or new environments. Traditionally, industrial robots are 'blind' in their performance and are only able to

grasp one way, with one gripping force. A more attuned sensitivity to the environment is a key advance to ensure safe human-robot interaction. To achieve this level of ability of grippers, you need a combination of soft manipulators, learning-based control schemes and soft sensors.

Such robotic applications will prove useful for high-precision tasks on assembly lines in factories and for performing assisting roles for humans, in settings such as surgery or working in marine or nuclear reactor scenarios. For pick and place tasks, or for example, giving close to real-life grip sensitivity in prosthetic hands, this technology is invaluable. The UK nuclear industry has already recognised the potential of the SMART-E gripper, which has been incorporated into a recent project for use in nuclear decommissioning.

## Reconfigurable and logistics robotics

Another problem identified by the research focused on robotic production lines. The upheaval and logistical challenge associated with changing the operation a specific line can be a fundamental barrier to the adoption of robotic and automation solutions for many companies. For a small business with budget and time constraints



to consider, changing its automation is an investment that's far too risky and time-consuming.

The SMART-E project sought to address this issue with the understanding it could lead to substantial economic benefits for many businesses. The solution was in a quickly deployable, flexible automation system for sustainable manufacturing. It worked by advancing the control-system-related technology of compliant and modular, reconfigurable robots. These systems adapt efficiently to frequent changes in the production line.

A new learning approach means robots can be trained online, without interruption of the production cycle. European manufacturers can adapt their production lines, which means they are competitive and as a direct result will drive employment for operators. Advanced machine learning techniques also improve the monitoring and maintenance of complex robotic systems, making the manufacturing process more sustainable.

## Safe human-robot interaction and cooperation

The 'holy grail' of robotics in terms of its importance for socio-economic benefits, is in developing robots that work safely alongside humans. By creating an artificial 'skin' for the robot, a skin with flexible sensors that detect points of contact, interaction capabilities improve. More importantly, the stretchable material of this skin does not interfere with the robot's mechanics.

Another advance in robotics that is key to shaping Industry 4.0, is in the development of a user-friendly programming system, which allows programming by physical demonstra-

tion, essentially tracking and copying movements. This means robots can be intuitively trained by non-experts. The upshot of this for the industry is that businesses can use and instruct robots effectively without the need for hiring specialist programmers.

A very exciting aspect of the project was the development of robust control techniques for wearable assistive robots, specifically exoskeletons. Such exoskeletons, with assistive components strapped on to a worker's arms, legs and torso, have the potential to reduce physical strain for workers in industrial settings when carrying out physically demanding tasks. These exoskeletons have the potential to reduce the risk of injury (and negate subsequent claims for injury settlements) and will be a welcome relief for many workers with physically demanding jobs in industrial settings.

## Outcomes of the science and the next steps in research in the field of robotics

The SMART-E project has pushed the state of the art further in the development of embodied intelligence, bio-inspired manipulators, the synthesis of modular robots, the design of exoskeletons and the control of rigid and flexible manipulators.

The team has published extensively (approximately 70 papers) in high impact journals and conferences including Soft Robotics, International Conference on Intelligent Robots and Systems (IROS) and the International Conference on Robotics and Automation (ICRA) and has registered several patents.

More importantly, the project has played a vital role in the research and training support given to a new generation of pioneering researchers and

developers in the field of industrial robotics.

Many of the research fellows have been recruited by world-class research organisations and businesses, where they will continue in their research into advanced robotics and automation solutions. The results of the research are used to improve automation and robotics solutions for the food and aerospace sectors.

We believe that the results we have achieved will allow European manufacturing companies to adapt their production processes to the trends that will define Industry 4.0. Robotic and automation solutions will ensure Europe's competitiveness in the years ahead.

Acknowledgement: The SMART-E project was supported by the EU FP7 Marie Skłodowska Curie Programme for Doctoral Training (Project ID: 608022). For more info on the Programme, please go to: <https://ec.europa.eu/research/mariecurieactions/>

Copyright Professor Samia Nefti-Meziani  
EU Research SUM18/P48



SUSTAINABLE MANUFACTURING  
THROUGH ADVANCED ROBOTICS TRAINING  
IN EUROPE

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# Automatically finding new cybersecurity threats with Open Source Intelligence

Monitoring cybersecurity-related posts in social networks and blogs can give security analysts an edge in discovering new threats against ICT infrastructures, according to Alysso Bessani

According to Lloyd's, companies lose \$400 billion to hackers each year, and, according to Gartner, companies will spend \$170 billion on cybersecurity measures in 2020. These losses, and consequent expenditures, come from the growing complexity and ubiquity of new cybersecurity threats.

A substantial fraction of these resources will be spent on research and consultancy about new threat models affecting organisations and the development and acquisition of tools to operate under them. For example, the widespread adoption of wireless networking and interconnected devices, together with the internet of things, are examples of recent developments that have a profound impact on the current cybersecurity threat landscape.

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**“To deal with this recurrent emergence of new cybersecurity threats in a more cost-efficient way it is paramount to design a new breed of tools capable of finding and consolidating information about new vulnerabilities and attacks against emerging technologies.”**

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A fundamental aspect of this phenomena is that by 2020, after these resources are spent, probably even more money will be spent to identify, prepare and protect against new cyber threats that will start attracting attention in the next decade. Maybe our attention will be focused on

attacks against artificial intelligence or machine learning systems that will be fundamental to our society, or on threats affecting a new generation of blockchains that will be supporting a broad spectrum of near-future critical services.

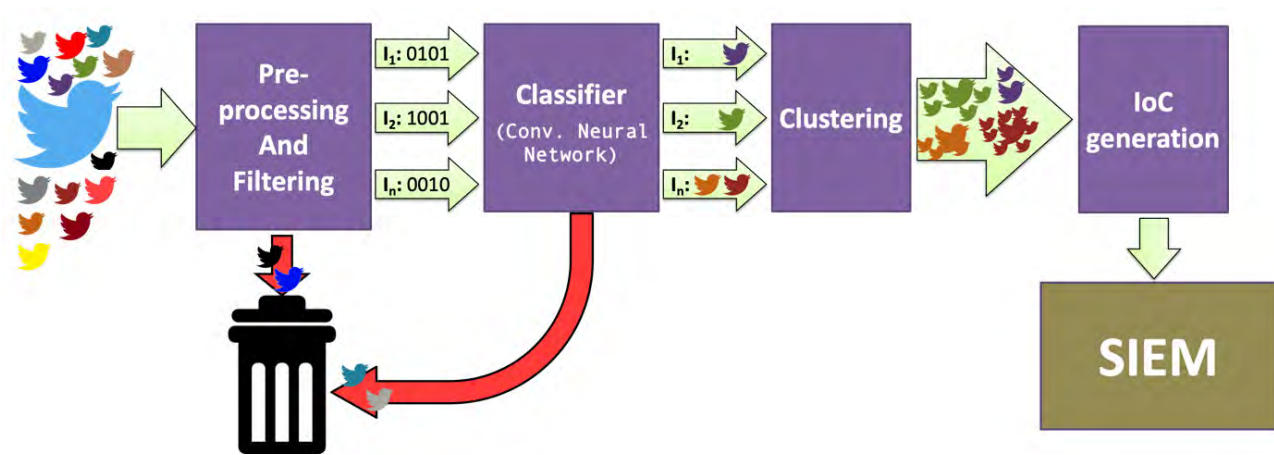
To deal with this recurrent emergence of new cybersecurity threats in a more cost-efficient way it is paramount to design a new breed of tools capable of finding and consolidating information about new vulnerabilities and attacks against emerging technologies. This information is widely available, in Open Source Intelligence (OSINT – a term used initially by the military intelligence community to denote the plethora of information on the news and other open-access sources) available on the internet in the form of security feeds, blogs, social networks, and the dark web.

There are two significant challenges in acquiring this information automatically. First, selecting the precious information that can give insight about imminent threats in the information deluge of the internet is like finding a needle in a haystack. Finding the sources that could give such information with greater probability is a challenge in itself, and, once they are found, it is still a challenge to filter what is relevant automatically. Second, most of the time this information will not be structured, requiring the use of advanced natural language processing

techniques for extracting and structuring the insights security teams are looking for.

These challenges can be addressed by exploiting the recent advances in machine learning for extracting information from big data. The H2020 DiSIEM project is devising a set of tools and services capable of solving these problems. The objective is to extract Indicators of Compromise (IoCs) from OSINT and feed this information as events to security information and event management (SIEM) systems and threat intelligence tools, allowing externally-collected information to be correlated with internal events obtained from the organisation infrastructure.

More specifically, a component called OSINT Threat Detector collects tweets from cybersecurity-related accounts and try to generate early alarms about possible threats affecting the monitored IT infrastructure. Twitter was selected as the primary data source for this tool as it is a kind of hub for the cybersecurity community and software vendors to disseminate alerts and engage in discussions about threats, vulnerabilities, and mitigation measures. By inspecting tweets, researchers have already shown that it is possible to discover vulnerabilities days or even weeks before their publication in reputed security feeds such as NIST's NVD (National Vulnerability Database), and



even finding which vulnerabilities have exploits available.

**“This pipeline employs several machine learning algorithms: a supervised binary classifier is used for selecting relevant tweets, an unsupervised on-line stream clustering algorithm is employed to aggregate related information, and a supervised name-entity recogniser is necessary for extracting structured information from text (e.g., what vulnerability a tweet is mentioning).”**

Besides common data pre-processing and normalisation tasks, the OSINT Threat Detector data processing pipeline (see the figure) uses keywords to narrow the set of tweets coming from the selected accounts. For example, if Windows 2000 is not used in the monitored infrastructure, there is no point in processing tweets about this system. After that, by acting on this subset of data, a binary classifier decides which tweets target the managed infrastructure security, discarding the others. After this step, clustering analysis is conducted over a time-based sliding window to find related events and compute distributions of keywords over time.

The resulting information allows grouping events that are likely to be

related to the same security issue or, more importantly, events that establish a connection between distinct security issues. In the end, the generated clusters are analysed, and IoCs are generated, to be processed either by the SIEM system or a threat intelligence tool like MISP.

This pipeline employs several machine learning algorithms: a supervised binary classifier is used for selecting relevant tweets, an unsupervised on-line stream clustering algorithm is employed to aggregate related information, and a supervised name-entity recogniser is necessary for extracting structured information from text (e.g., what vulnerability a tweet is mentioning).

Besides the OTD, the project is also designing a platform for searching and analysing OSINT data in Twitter, blogs, and even in the dark web, by exploiting the DigitalMR Listening247 platform. Finally, a third OSINT processing component is responsible for enriching the generated IoCs with a threat score and correlating them with the alarms generated by the SIEM system. Together, these tools provide a unique set of cybersecurity OSINT processing solutions that go from alarm generation based on timely microblog posts to correlation

with internal alarms from the SIEM and to further analysis of threats in a unified platform accessing a wide variety of OSINT.

For more information about DiSIEM OSINT processing solutions and other SIEM enhancements being proposed on the project, please see our website: <http://disiem-project.eu>

DiSIEM is supported by the European Commission through the H2020 programme under grant agreement 700692. The project consortium is composed by seven partners: FCiências.ID, City University of London, EDP, Amadeus, DigitalMR, Fraunhofer IAIS, ATOS.



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# Accessibility: The key to making government work better

Joshue O Connor, Head of Accessibility (Interim) at Government Digital Service (GDS) argues that accessibility is the key component of making government work better

**T**oday, we hear much talk of ideals like inclusion and equality. Without practical application, any ideal is aspirational at best. How are inclusion and equality to be achieved?

## Can accessibility make government work better?

The web is a powerful tool and a democratising force in our lives. It levels the playing field, makes a meritocracy possible. For diversity of ability to thrive in our technocratic culture, standards to simplify information for everyone are powerful and more than ever needed.

Accessibility comes from user involvement, good code and design practices. Most barriers for disabled people are unintentional. No one sets out to build inaccessible services.

## Why does accessibility mean more than putting things online?

It is about making things work for people with disabilities. This simple definition helps to focus attention in a practical way. To initially talk about 'everyone' is nebulous.

Accessibility does not just 'happen'. It needs care, attention, discussion, argument, effort and failure. 'Try again. Fail again, fail better' to paraphrase Samuel Beckett. This is at the heart of Agile, the development model that is the new darling of government. Effective accessibility is a deep cultural wave that moves sideways. It is not a 'vertical' but a horizontal culture, a wave – that ebbs and flows touching designers, developers, content people, policy people, procurers and more.

Accessibility just does not work in silos. Nor, in progressive organisations, can it be contained. It grows and thrives in a culture where the various players support

the organisational goal of making things accessible, with the understanding that making this happen takes, time, effort and mutual goodwill.

## Why is it important that a public sector website or app works for everyone?

There are push and pull factors that make accessibility so important to the government. There is a moral obligation and an impetus to honour and maintain the 'social contract'. There are also practical fiscal considerations such as enhanced revenue generation from gathering more taxes, quickly and efficiently and having effective well-designed services that meet real user needs.

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**"The web is a powerful tool and a democratising force in our lives. It levels the playing field, makes a meritocracy possible. For diversity of ability to thrive in our technocratic culture, standards like accessibility are powerful and more than ever needed."**

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Without efforts to embed accessibility in service creation, they may be totally inaccessible to many people. Putting the user first, collecting user needs and building services around those needs; are at the heart of progressive government. These are cultural paradigms that inform the spirit of what accessibility is and how it relates to effective public service.

## Why is it important that all public sector websites meet accessibility standards?

There are legal requirements to comply with the Equality Act 2010 (the Disability Discrimination Act 1995 in Northern Ireland) and the EU Directive on the Accessibility of Websites and Mobile Applications of public sector bodies. However, these are 'sticks'. At Government Digital Service (GDS), we are aware of the 'carrot' and



how the practical application of an accessible culture will better meet the needs of government and the public. By designing for extremes, we can better serve the needs of more users.

### **Accessibility: A perfect challenge**

Government exists to serve the public but also itself. Accessibility can help achieve both goals. As an engineering issue, accessibility is the perfect challenge.

While adhering to standards is no doubt important, it is not the end goal. There is a 'spirit of accessibility' which is about doing your best, as a service provider; driven by a moral imperative or realisation that this is the 'right thing to do'.

In order to adhere to the social contract, the government must take an active role to provide accessible platforms and services, while nurturing an accessibility culture across its services.

### **Accessibility and the future**

We can speculate that in a positive vision of the future, accessibility will just disappear because it becomes a

basic part of building any great product or service. It will be a part of the 'definition of done'. This future always seems to be just 'around the corner', or in the next update.

In a more realistic future, platforms and technologies will still need attention from accessibility experts and user involvement to effectively build services. Machine learning and so-called artificial intelligence (AI) or automated machine reasoning may have a part to play bringing new opportunities and potentially new barriers.

While it may be algorithms or rules that are used to determine what is required to facilitate a humane user experience. Who will write those rules? ■

**Joshue O Connor**  
**Head of Accessibility (Interim)**

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# Maintaining accessibility through the EU Accessibility Directive

Mike Taylor, Senior Accessibility Analyst and Comms and Training Manager at Digital Accessibility Centre shares his thoughts on maintaining accessibility through the EU Accessibility Directive

**D**igital 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 users 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.

Recently [Sept 2018], the EU Web Accessibility Directive became legislation. This applies to UK public sector organisations. Using existing guidelines which form part of the Web Content Accessibility Guidelines (WCAG), members should ensure that as much content as possible is accessible to all users of desktop and mobile devices, including website and app content respectively. Point 19 of the EU directive indicates this to include textual and none textual information, including downloadable forms and documents,

identification and payment processes, as well as applications on mobile and desktop devices. This is taken from section 19 of the directive: 'EU Accessibility Directive ST\_9389\_2016\_REV\_1\_EN'.

The recent legislation mandates compliance with EN 30549 which maps directly to AA level of WCAG 2.1, ensuring that monitoring and on-going testing is carried out to maintain the accessibility of electronic content moving forward. A list of exemptions are included within the directive, to take into account a variety of scenarios based on other factors which affect public sector organisations. An exemption in this instance means that at the moment, an organisation will not be required to comply, or an organisation will have more time to implement a solution based on their activity online. Point 22 of the directive does indicate that items which may currently be exempt, are subject to change if it is deemed possible to implement accessibility at a later date. In the same way as WCAG, all content should follow the same four principles which are:

- Perceivable, meaning that content should be displayed in a way that is easily navigated by all users on multiple devices.
- Operable, meaning that all content should be able to be displayed and interacted with by multiple users on a wide range of devices.

- Understandable, meaning that the content and user interface should be presented in a way which is easy to understand and use, and:
- Robust, meaning that all content and controls will work with a wide range of software including assistive technology.

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**"Although the directive will become EU law, the other reasons for its use are to ensure that all public sector organisations provide accessible content."**

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## What are the exemptions of the EU directive?

The exemptions depend on each scenario, however, the following provides some instances where an exemption may be possible.

- Electronic documents such as word or PDF files, which are produced prior to 23/09/2018.
- Pre-recorded content which has been recorded and posted online before 23/09/2020.
- Live content which is not recorded, such as a live news or another event which is being broadcast.
- Online maps or services which rely on the use of maps, as long as an alternative version is kept available and maintained to ensure it is up to date.





Taken from the [Web Dev Law blog](#).

## Why is it important?

Although the directive will become EU law, the other reasons for its use are to ensure that all public sector organisations provide accessible content, no matter if being viewed on a desktop or mobile device. As the Family Resources Survey 2016/17 from Direct Gov indicates, 22% (13.9 million) people reported a disability in 2016, compared to 19% (11.9 million) in 2013/14. The survey also indicates that the increase is reported to be people of working age, and state pension age respectively. Taken from:

The [Family Resources survey 2016/17](#) can be found at the [Direct Gov website](#).

Taking the above into account and excluding persons who are not registered as having a disability, the figures

are likely to be higher than indicated. [The Equality Act 2010](#), which in this instance applies to all areas of the UK, apart from Northern Ireland where the Disability Discrimination Act (DDA) is in place, defines a person who has a disability as: "A physical or mental impairment that has a 'substantial' and a 'long-term' negative affect on your ability to do normal daily activities".

The directive will ensure all persons who believe they have an accessibility requirement, are able to obtain equal access to information and services. However, being accessibility compliant will also make your search engine optimisation (SEO) more effective, as web pages which are designed to meet WCAG 2.1 are likely to gain higher rankings in search results.

Good accessibility practice will also make your content easier for every-

one to understand as content will have a clear and logical structure, and easy to find information when navigating a website or application. Find out more about the [EU accessibility directive](#).

"DAC's team of accessibility analysts, trainers, technical support and web developers supplement users 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."

If you require further information or support please get in touch with DAC at [info@digitalaccessibilitycentre.org](mailto:info@digitalaccessibilitycentre.org)

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# Digital transformation and local government: Asking the right questions

Callum Sherwood, Public Sector Specialist at Freshworks provides insight into the world of digital transformation and local government and ponders if we are asking the right questions in this vein

**M**ore of the services we rely on every day are moving online. Everything from projects like education and healthcare through to information on when bins should be collected is available online, and more of these services are being extended using mobile apps and self-service tools. However, many councils and public sector bodies are still running their activities with a traditional mindset rather than one developed to take digital into account from the start.

TechUK, an organisation representing the technology industry as a whole in the UK, has addressed this with its own paper in September 2018 on how councils should appoint more leaders that have skills and understanding around IT and digital in order to build a “digital first” mindset. Georgina Maratheftis, programme manager for local government at techUK, commented on the launch: “By grasping the digital

agenda and having a digital-first mindset, councillors can be at the forefront of spearheading the transformation of the area into a ‘smart community’ where citizens are empowered to shape services and create the places where they want to live.”

However, getting the right information to leadership teams around service quality can be difficult, whether those services run on digital or not. So how can you get more accurate data on how digital services are performing, and how can you share this insight internally?

## **Building a bigger picture of your services**

The first problem for many public sector bodies is how they get their data together in the first place. Without that information on how services are being used, it is difficult to see how well services are delivering on customer expectations. When data is being captured, getting it into the right context can also be a challenge.

Solving this problem is not just a question of sampling data. For many councils, existing helpdesk systems don't capture the right data for reporting on interactions with customers. Getting more data from these systems can be difficult as well, particularly with multiple channels available for customers to use.

Consolidating all these channels together is only part of the story. Getting data ready for reporting purposes is another project. Making it easy to look at this data and ensure it is understandable for others is just as important. By building up a picture of how well customers are supported today, you can start to plan ahead around where you can implement those new services to make the most difference over time.

For example, chatbots have started to extend beyond online retail sites and into more markets and other use cases. Being able to provide simple responses to direct questions – when bins might be collected for a specific postcode, for instance, or information on specific opening times for public services – is a great example of where chatbots can be useful in the public sector.

However, investing in more digital services and automation like this should not be undertaken without looking at how that kind of service might be in demand or not. This user-driven approach has to be based on quantitative data from service channels. For example, are there already lots of requests for specific services coming through phone or email? Is the website with that information getting a lot of hits?

By taking data on existing request levels, you can think ahead on where to concentrate your efforts. For problems that lead to a lot of human agent requests, putting in new investment to deal with those requests can free up a lot of time that can be spent on more pressing issues that require more subtle and creative responses.

Conversely, if existing digital services like the council website already fill that gap adequately, then it will be worth putting more effort into dealing with other problems. This ability to understand which issues affect most people can help define where investment in new digital services can be directed to have the most impact. By using this data from citizen interactions, budgets can be made to go further.

## Digital transformation and public sector objectives

Getting good data on customer interactions can help provide more insight into what is taking place over time, and where smaller steps can be taken to reduce human interactions and make more use of automation. Alongside migrating this day-to-day activity to digital, you can consider how to develop new services that can deliver significant improvements in how customers are supported.

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**“Everything from projects like education and healthcare through to information on when bins should be collected is available online, and more of these services are being extended using mobile apps and self-service tools. However, many councils and public sector bodies are still running their activities with a traditional mindset rather than one developed to take digital into account from the start.”**

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This approach builds on data and digital expertise that you have in place, but it also relies on understanding how customers think and approach things in general. Where this differs from more traditional channels is that these services are not like for like replacements; instead, they combine services and technology in new ways. For example, this may involve creating new mobile apps that can wrap together information and services that people can access wherever and whenever they want; alternatively, it may stretch to using new technologies like augmented reality to provide additional information to people when they need it.

Building digital services on these new channels should help extend how customers can get support from local government organisations. However, these services should always have support built in, to make life simpler for citizens. By understanding the possibilities inherent in new digital developments, councils can implement better services for the communities they serve. ■

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# Increasing productivity through online collaboration

Jason Fahy, CEO, Knowledge Hub explains how organisations are increasing productivity through collaboration

**F**or public sector professionals, Knowledge Hub is the place to go to collaborate online.

For some, 'collaboration' might seem a tad soft or lacking in focus and a more social than professional activity. This isn't so for the Knowledge Hub community, where collaboration is synonymous with increased productivity. Whether sourcing content for research, seeking a rapid answer to a local challenge that is likely to already have been solved elsewhere, or crowdsourcing input to service redesign, the result is increased productivity.

**"We talk about our desire to make a difference as a business and it feels as if we can now achieve this on a global level by increasing the productivity of 100 RC member cities through collaboration."**

One recent example is the collaborative approach taken by Scottish local authorities who came together to collectively respond to the GDPR regulations that recently came into force. Their shared approach to this common challenge was facilitated by the Digital Office for Scottish Local Government whose Readiness Project helped to remove duplication and save more than £1 million. Knowledge Hub was used by 30 of the 32 Scottish local authorities participating in the Readiness Project to share challenges and find collective solutions to implement-



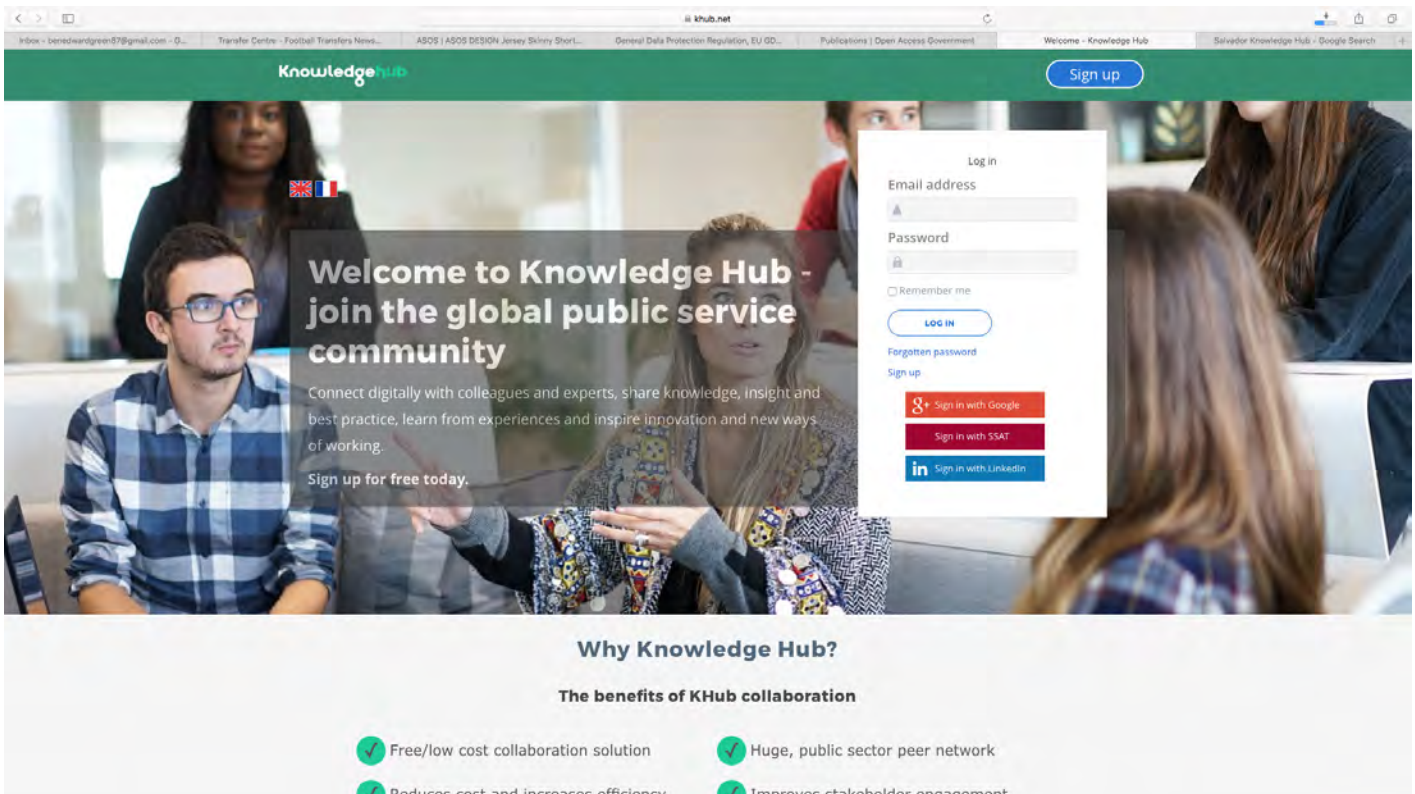
ing GDPR. The Digital Office reported that this helped to sizably reduce any duplication of effort and ensure a consistent approach between the 30 councils in the Local Government Digital Partnership.

The need to stretch limited public service resources is adding momentum to the growth of the Knowledge Hub community. The reported successes, such as those described in Scotland provide a growing global audience with tangible evidence of the rapid and significant return on investment. The use of Knowledge Hub to harness collective approaches to common global challenges is fast emerging.

With the recent announcement of its appointment as a platform partner of 100 Resilient Cities – pioneered by the

Rockefeller Foundation, Knowledge Hub seeks to support the 100RC network of Chief Resilience Officers with the implementation of resilience strategies by making it easy to engage with stakeholders, partners and local communities in the various initiatives.

Salvador, in Brazil, has been the first of the 100 Resilient Cities to seize the opportunity. Salvador is a vibrant coastal city with strong shipping, industrial manufacturing and tourism sectors. Its population of 2.7 million has been swelled by an influx of domestic migration that has taxed public services including education, healthcare and transportation, while the ensuing overpopulation has increased unemployment, informal settlements and poverty. New initiatives have been enacted to increase



foreign investment to increase job opportunities, while a government agency was created to provide job training and assist in connecting employers with residents searching for work.

**“Knowledge Hub was used by 30 of the 32 Scottish local authorities participating in the Readiness Project to share challenges and find collective solutions to implementing GDPR. The Digital Office reported that this helped to sizably reduce any duplication of effort and ensure a consistent approach between the 30 councils in the Local Government Digital Partnership.”**

Salvador experiences regular heavy rainfall that can lead to devastating urban landslides. During the last 10 years, the Municipal Civil Defence and other government agencies have assisted in over 19,000 landslide related occurrences, providing support to rebuild property and in many cases relocate citizens. Further engi-

neering work is underway with federal support to stabilise landslide-prone neighbourhoods, but rapid population growth increases the possibility of future risks. Salvador will launch their Knowledge Hub network in early June and begin to engage their communities in tackling identified shocks and stresses covering crime & violence, disease outbreak, inadequate educational systems, landslide, population growth & overpopulation, poverty and rainfall flooding.

Fahy commented that Knowledge Hub is extremely proud of its association with 100 Resilient Cities and excited that Salvador has moved quickly to adopt the platform. He explained that the technology will be deployed in Brazilian to enable engagement in the native language. We talk about our desire to make a difference as a business and it feels as if we can now achieve this on a global level by increasing the productivity of 100 RC member cities through collaboration.

Knowledge Hub is free to public service and not-for-profit organisations and their employees who can access the platform at [www.khub.net/sign-up](http://www.khub.net/sign-up).



## Knowledgehub

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# How you can improve the way you design and improve services with modern software in the digital age

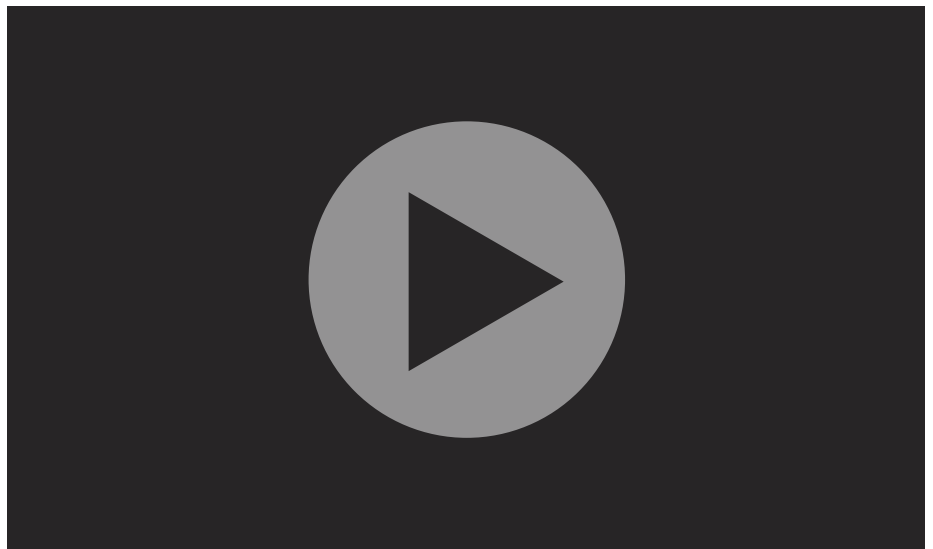
Andrew Sandford, Director of We are Lean and Agile, explains how modern software can help you understand and improve your services in the digital age

I agree with [Grace Hopper](#) that “the most dangerous phrase in any language is – we have always done it this way”. She was a truly inspirational person in early computing and accumulated 40 honorary degrees across her career. This phrase is also pivotal when looking at processes and service design in your own organisation and no doubt your business analysts will be busy removing these tasks and improving your processes.

**“Processes can be shared for wider feedback and collaboration immediately after the workshops in the format the stakeholders are familiar with, this means more collaboration faster giving better quality outcomes.”**

Something that happens less frequently within our improvement programmes is us actually looking at how we deliver improvement across the organisation. Agile and design thinking have come in and are delivering better ways of implementing solutions and of understanding our customer needs. Fundamentally, the way we have understood existing and designed new processes have not changed in many years. The process involves lots of workshops, sticky notes, write-ups, delays and transferring information from one format to another.

With modern ICT services and Agile



delivery, your process improvement approach also should be delivered in a user-centred efficient manner to ensure your business continues to thrive (or even exist).

## The legacy approach to improvement

There is a standard way of understanding and improving processes through workshops. Often your analysts will host multiple workshops with stakeholder groups. During these workshops, your analysts capture processes and other information mainly with sticky notes, brown paper and flipcharts. These workshops are used to capture an understanding of the As Is process and opportunities for improvement. Following the workshops, your analysts need to find the

time to write all this up and transfer the maps and ideas into other tools like Visio or a BPMN modeller and maybe Word and/or Excel. This takes a lot of time generally and delivers little value in terms of outcomes.

Following the As Is work there may be a sign off process requiring a report, or the analysts may continue and produce a To Be version of the process. Ideally, the analysts work with the original stakeholders to redesign the process again utilising sticky notes etc during the workshops. Again, lengthy write-ups follow and more in terms of elapsed time. Following this, some manual work needs to be done to identify the benefits of change and potentially the business case for change.



## So, what are the issues with that?

The first challenge with this process is how manual and time consuming it can be. With modern Agile delivery practices solutions can be delivered fast, time delays mean that not only are you achieving benefits slower but also that services may well have delivered some of the proposed improvements by the time you complete your improvement designs. You are also consuming a large amount of your analysts' time in doing low-value transfer of data.

If you have delivered the workshops with individual stakeholder groups from across the process only the analysts have studied and understood the end to end process, missing the opportunity to spread the knowledge.

Stakeholder engagement and buy-in can be hampered by this process also. The sheer time to deliver an outcome disengages stakeholders. The processes the stakeholders mapped and the documentation that comes back to them after the workshops look completely different (e.g. sticky notes vs process maps). The traditional method can make it very much feel like something that is being done to us rather than with us.

Most importantly, the benefits identified are calculated manually and have no real connection to the process maps themselves. This means the inevitable changes and updates in the designs need to be manually reflected across into the benefits. Benefits tend to be calculated at a high level as calculating the true cost of a process with often a hundred steps can be immensely complex.

Finally, process maps are often done just for a project and are then shelved

or left to get quickly out of date. Due to the stakeholder engagement issues, there is not much ownership in the business or use of the outcome process maps. The transition of the new service into live use can be more problematic if your stakeholders are not engaged in the change process.

## What can be improved about that?

Processes and sticky note exercises can be captured and projected live in workshops saving the analysts 30-40% of their time not doing write-ups.

Representatives of all stakeholders of the end to end process need to be in the workshops together to share understanding and identify more improvements.

Processes can be shared for wider feedback and collaboration immediately after the workshops in the format the stakeholders are familiar with, this means more collaboration faster giving better quality outcomes.

Process maps and models contain more than images of a process. Processing time, lead time, waiting time and fixed costs are captured in your maps along with a multitude of other statistics. This means you can calculate the cost of your As Is process and To Be versions and generate the benefits profile directly from your maps. This not only saves more analyst time but also gives an accurate benefits calculation and some powerful analysis tools to help identify improvements.

Your 'To Be' process map can be published to a digital process handbook and feedback allowed to ensure maps are not thrown away at the end and also supporting the identification of more improvements supporting the continuous improvement cycle.

The tools are so user-friendly that someone who has not done any process mapping can learn in a day and map like a pro. This enables process improvement to be embedded in the service areas and becomes part of the organisation culture as well as increasing ownership. There are many other benefits on top of these.

## Why don't you already know about this?

We have only been in the UK for a couple of years. The tools have been used in Holland for over 15 years and 33% of public sector use it over there. It is 50/50 split for users across the public/private sectors including some companies big and small, including Schiphol Airport, Bavaria Beer and the Dutch Post Office. We have over 30 predominantly public sector users in the UK including the City of Edinburgh, Cardiff and Exeter Councils.

We have a free month's trial, so the question has to be why would you not want to take a look?



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# The future of digital transformation: Is it an IT or a business challenge?

In an interview with Rob Bamforth, Industry Analyst and Marketing Consultant at Timefort Limited, following a OneLogin's 'Identity IS the new perimeter' roundtable in London in late 2018, we find out his thoughts on digital transformation and where he sees it heading in the future

On Tuesday 16th October 2018, Open Access Government attended [OneLogin's](#) 'Identity IS the new perimeter' roundtable in London, which included insights into digital transformation and how it is manifesting itself in businesses. The participants include Rob Bamforth, Analyst, at [Quocirca](#), Thomas Pedersen, CTO and Co-Founder, OneLogin, Stuart Sharp, Global Director of Solution Engineering, OneLogin and James Thompson, IT Manager at [Catawiki](#).

One aspect of the OneLogin roundtable discussion explained by Rob Bamforth is that as organisations move through what is often called digital transformation, how do they need to keep control of access and identity and how is that all changing? He argues that digital transformation is no longer solely a technical or IT challenge for organisations, but it is also a business challenge.

Immediately following the insightful OneLogin roundtable discussion, which covered much ground, Open Access Government was fortunate to speak with Industry Analyst and Marketing Consultant at Timefort Limited, Rob Bamforth to find out in more detail his views on digital transformation and where he sees it heading in the future. Firstly, the extent to which organisations across all industries are undergoing digital transformation and cloud migration was a point Rob underlines.

## The shift to digital transformation

To set the wheel in motion, Rob explains how many organisations today are shifting in various ways. He emphasises that digital transformation is a very broad term and can mean different things to individuals. Rob

adds that one thing it does mean is the streamlining of processes that impinge upon all stakeholders, a point he elaborates to us.

"In many organisations, the internal digital transformation is affecting the relationship employees have with their employers. Much of this involves self-service type approaches, more automation and portals where you can access and do things yourself, rather than relying on other resources that most organisations have now got rid of."

"Increasingly, it's the external relationships which are of more interest, because not all organisations today deal directly with consumers, but those that do are definitely transforming that relationship. You can hark back to whether it is retail or retail banking, and you can see physically the change from branches and talking to tellers inside the branch, to talking with the ATM to going online and accessing an app on your phone."

"The escalation route that is now available to you from an app or via a website is increasingly digital, so this is a part of the transformation that organisations have had to go through."

So, the picture Rob paints of digital transformation is clearly one of full automation, for some organisations, this means having remote workers on a video link using chatbots. There has been a massive shift in terms of how customers are dealt with, and in the middle, of course, there are the interested parties in the supply chain. Rob says that they can access the IT directly, which fundamentally shifts a whole load of processes along.



### **Authentication: The barrier between the end user and the application**

The conversation then progresses to detail Rob's opinions on the only barrier between the end user and the application – and indeed the success of digital transformation – the identity of the user. Rob explains that when an interaction becomes valuable, such as the opening and closing of an account, or a financial decision, there is something much more serious going on. The relationship has gone up a notch, Rob underlines, adding that in this case, you need to know whom you are dealing with. In terms of web traffic, there has been an increasing shift to the use of 'https' for a secured website, so you can authenticate who you think you are dealing with.

On the subject of authentication, we know that the British Red Cross is a great example of a company who have implemented software as a safer Identity provider (IdP) to single sign-on. In this instance, we know that it was crucial that the technology used is not only reliable but scalable and agile. Ensuring secure access for many employers, often working remotely,

requires modern technology solutions such as Office 365 and a single sign-on (SSO), whenever and wherever required. This does, however, work for many other organisations alike, not only the British Red Cross.

Added to this, British Red Cross needed more than SSO because they work with organisations such as the NHS, which means that Level 2 compliance and two-factor authentication is the best route to fulfilling stringent access criteria. The software the organisation used was implemented as a safer Identity Provider (IdP) to single sign-on and then provided the two-factor authentication for their internet-facing, key business applications.

From OneLogin's perspective, they felt the implementation went very well in the view of Phil Paul, Head of Service Delivery at the British Red Cross. The planning took a few weeks, but they transitioned the software used in just one evening. "Ensuring implementation happened seamlessly was of the utmost importance to us and we didn't experience any disruption to our Office 365 service, so it was a very successful transition", Phil notes.



## Identity, credential management and ease of use

The interview with Rob Bamforth, Industry Analyst and Marketing Consultant at Timefort Limited continues as he explains his thoughts on identity, credential management and ease of use when everything is put together on one platform.

“The identity of the individual performing the action is becoming crucial, but if we go back pre-digital transformation, people were verified in many different ways. As soon as you remove the physical connection, however, you need other forms of credentials. The more you push contact through this single bottleneck point, the more that credential model becomes important.”

“Over the past decade, everybody was trying to do this and began introducing their own form of credential management, logins, passwords and everything else. Even if those approaches are simple, what you end up with is a proliferation of many of these which are horrendously complicated when used en masse.”

“During the ‘Identity IS the new perimeter’ roundtable, we discussed the iPhone. Indeed, we know that Apple has not just focused on the ease of use but the aggregate use, that is when you put everything on to one platform and make them all easy to use together.”

## Business continuity

Rob adds that in this vein, the user is always the weakest link who will take the easiest approach when that is available. We then pick up on another aspect that was discussed during the ‘Identity IS the new perimeter’ roundtable: backing up your content to the Cloud. In terms of backing up, it’s worth considering why is this important for organisations in terms of business continuity?

Rob explains that in the past, not only did we think about doing backups, but we also thought about not backing things up in the same place in succession. He

stresses that the backup process itself, in his opinion, is not that important, but the restore process is. When it comes to business continuity, Rob takes us back to a time when he was a software developer and had a massive (by the standards of the time) data repository to create which we were going to back up.

“In terms of the restore scenario of a network, we reckoned that it would take a year to do this. To my mind, levels of data storage have now gone up massively in comparison, but the problem remains. It’s not about the backing up, but how do you then use that in business continuity. What is important today is that you can resume service as soon as possible.”

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**“In many organisations, the internal digital transformation is affecting the relationship employees have with their employers. Much of this involves self-service type approaches, more automation and portals where you can access and do things yourself, rather than relying on other resources that most organisations have now got rid of.”**

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“If the continuity is there in terms of something held non-locally – we’re all flexible about how we use IT – so not storing locally means that access point becomes ephemeral. If it breaks, we can immediately get going with another one, so we don’t lose continuity”

“One of the strong values of a Cloud-based model is that you have instant restoration of service because you are not having to move things around. I think that as soon as you outsource a responsibility for maintaining the data and a resilient form of bringing it back, you are paying them for that service and you are expecting them to give you a higher level of capability than you could ever do yourself, because there are colossal economies of scale at play.”

## The increasingly complex technology environment

As an expert in the field, Rob then imparts his views on

the increasingly complex technology environment for government or businesses, specifically around how they manage the growing volume of apps, security risk, and the expanding (and increasingly diverse) set of users, whether they are internal employees, external partners, or even customers.

When it comes to departmentalisation and the vertical integration of a solution around that, Rob says that in terms of the government departments they are very siloed. When you start to try and operate across departments, there are of course inevitable compromises, as well as potential risks.

“Over the past decade or so, there have been issues around government departments sharing their data between each other, and is there a risk here? While there is a need to balance these things, there has been a big shift over the last five years with Cloud-based resources in that this has allowed departments to start to think differently about what sort of services they require and not having to vertically integrate the whole lot.”

“You then end up with powerful horizontal platforms that are capable of delivering a service, so you can focus on what it is important. What happened with the Government Gateway is that you ended up with one for a set of requirements around HMRC which could be replicated in other areas of the government. As it wasn’t turned out into a horizontal service that was universal, it didn’t get adopted.”

“If you make it a common service, you reduce the overhead of having to build your own applications. You are essentially reusing and leveraging something that somebody already has put the effort into. It might not be 100% perfect, but if it does the job then it is a service you can use. This is a difficulty for any organisation that has become siloed, but there are services that are common and should be applied in a common way.”

### Where digital transformation is heading

As this interview draws to a close, Rob reveals where he sees digital transformation heading in the future. He picks up on another theme from the roundtable discussion, that concerns the potential for collaboration between different security providers of the Cloud, with each of them offering different elements of security, encountering the threats coming in and the sharing of intelligence between them.

Rob predicts that we will see more of this in the future, so digital transformation will shift to much more horizontally-led platforms and capabilities, as he concludes in his own words.

“With that horizontal layering, you then get the opportunity for collaborating with other organisations, both on an internal and external level. This mirrors the conversation around security, which used to be seen as a physical perimeter around an organisation and now that is essentially virtualised. So, I think you can regard identity and access management as a virtual perimeter, and while we thought virtualisation was something that applied to servers, it actually applies everywhere.” ■

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# Approaching digital transformation in government: The Internet is OK

Peter Miller from Visionist Ltd explains his perspective on approaching digital transformation in government and the move toward cloud-based solutions

Ever since UK government departments have been assured that “the Internet is OK”, they have adopted a mandated cloud-first approach to digital transformation. The civil service has, therefore, seen an increasing number of applications being provided as Software as a Service (SaaS) from the web, which is a promising move in a future-proofed direction.

However, many department users will remain reliant on legacy physical line of business (LOB) applications that are hosted on the Public Services Network (PSN) for some time to come. This can be frustrating, with users dealing with the need to switch between PSN and the cloud, multiple log-ins, locked-down machines to meet various security protocols, and denial of access to other web services.

## What does the future look like for the PSN?

It's clear that some business applications will continue to reside on the PSN for the next few years, not least because they were procured to ensure that whole-life costs were amortised through an extended life. However, it is equally clear that as the number of applications hosted on the PSN decreases, this legacy infrastructure will no longer be cost-effective to maintain. Although no date has been set to ‘switch-off’ the PSN, it is inevitable that this will happen at some point as more departments seek



to move towards secure, cloud-based, commodity services.

## Supporting evolution, not revolution

In the meantime, what can be done to minimise the impact to the user while managing the need to migrate from PSN services to cloud-services?

Logically, users need to be able to access both cloud services and legacy LOB services from a single machine, where the user can be ambivalent or even oblivious to where these services are hosted.

The solution? The implementation of an interoperability gateway, which enables departments and the public sector to easily move away from the PSN and onto the internet/cloud but continue to reach back to PSN hosted legacy applications and services.

Implementing interoperability gateways provides HMG Departments with a long-term, strategic approach towards operating networks in a modern and secure way, allowing the migration of legacy applications to take place as an evolution, rather than a revolution.

That said, those who lag in the ever-strengthening trend toward cloud-based solutions may find themselves migrating through necessity as the PSN expires.

## What is an interoperability gateway?

An interoperability gateway is an integrated secure software stack which presents the ability to deliver a single sign-in experience across multiple security domains, with security policies being applied, per application, not per device. It provides a superior user experience.



perience for a relatively small investment, eliminating conventional on-premise costs such as implementation since the gateway could be delivered as a service. This could provide the rest of the public sector, using economies of scale, with a cost-effective route to interoperability and potentially offer the ability for consumers to migrate to web-based commodity services sooner.

The benefits of an interoperability gateway are as follows:

- Enables department to focus on their core capabilities and make extensive use of the vendor's expertise.
- Eliminates the initial investment cost with a lower support and maintenance cost.
- Delivers measurable security by leveraging existing identity providers within each organisation.
- Easily upscales or downscales to meet changing business needs.
- Encourages LOB application owners to investigate earlier migration to the web.

Another benefit is the cost-saving associated with the redundancy to rely on Multi-Protocol Label Switching (MPLS); one of the major costs associated with accessing services hosted within the PSN via the internet.

## Risks and challenges

Delivering a secure interoperability gateway needs to be carried through with a robust implementation plan to avoid security issues associated with data privacy and reliability. Further policies for authentication, backup, recovery and deployment standards are essential. Adherence to these policies will ensure high availability, scalability and reliability.

Once implemented, an enterprise needs to ensure a uniform approach as there is little opportunity for individual user customisation (this endangers the overall premise of a seamless single log-in user experience).

## The interoperability gateway in action

Visionist has implemented an interoperability gateway supporting the BEIS community of 7,000 user devices, allowing users to access legacy PSN-based data centre services and cloud-based commodity services simultaneously using the internet as the bearer network.

Visionist designed, developed, delivered and now support the service. Following best practice and NCSC guidelines, DevOps supports a continuous improvement plan and migration of legacy services. Migration thus takes place when a service delivers benefits to the Department in a cost-effective manner, rather than owing to technical necessity.

To read more about Visionist's work with BEIS [click here](#).

## A Crown Commercial Services supplier

Visionist was recently reconfirmed as a Crown Commercial Services-approved supplier on the UK government's Digital Outcomes & Specialists 3 and GCloud 10 Procurement Framework on The Digital Marketplace, joining an elite group of over 1,200 Crown Commercial Services suppliers.

Visionist's government clients have included the Departments for International Trade, Business, Energy & Industrial Strategy, Energy & Climate Change, and Education; the Ministry of Defence and Home Office; and The Oil & Gas Authority, Office of Commu-

nications (Ofcom), HM Revenue & Customs, Innovate UK and the NHS. Visionist's interoperability gateway is available as a service via the [digital marketplace](#).

## About Visionist

Founded in 2009, Visionist has extensive government delivery experience and extensive experience in delivering digital solutions to large organisations.

Visionist's 100+ permanent staff and wider resource pool of over 800 subject matter experts help organisations achieve their business goals through strategic leadership and digital innovation.

With a new partner, [Smarter Business](#), Visionist can offer a host of other business services, such as business energy, telecoms solutions, facilities maintenance, smart building monitoring and more.

To digitally transform your organisation, let's talk:

+44 (0)20 3883 8201 or visit  
[www.visionist.consulting](http://www.visionist.consulting)  
[www.smarterbusiness.co.uk](http://www.smarterbusiness.co.uk)



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# Digital transformation helps central and local government make resilience a reality

Sungard Availability Services Ltd explores the pressure central government departments and local authorities are under to achieve more with less and how digital transformation can help to achieve their business outcomes

**W**ith spending cuts and population growth a reality, central government departments and local authorities alike are under pressure to achieve more with less. In response, many are forming new partnerships, adopting innovative ways of working or embarking on digital transformation projects.

Finding they lack the resources or specialist expertise in-house, some central government departments and local authorities are turning to Sungard Availability Services, a leading provider of custom production and recovery IT services, to help them achieve business outcomes. Sungard AS successfully partners with government departments, local authorities, housing associations and other public-sector organisations to transform the IT infrastructure underpinning public services and improve organisational resilience.

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**“Gone are the days when businesses, residents and taxpayers would tolerate downtime while a heroic recovery was executed.”**

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Many organisations believe they have protected themselves from business disruption by implementing a business continuity plan. But that is no longer enough. Gone are the days when businesses, residents and taxpayers would tolerate downtime while a heroic recovery of IT systems was executed. Today's

citizens expect the organisations they deal with to be always-on, which means public sector organisations need to be both agile and resilient. The government needs to be able to handle change and deliver expected services without interruption, regardless of any obstacles encountered.

In the past, IT systems that were rigid, slow and expensive to change were a barrier to achieving this goal. With organisations today almost completely reliant on technology, there is little incentive to make other parts of the business agile when anchored to IT systems that are rigid, slow and expensive to change.

However, cloud computing offers the agility, flexibility and lower lifecycle costs that free the rest of the organisation to adapt to withstand and even flourish, in response to change.

Sungard AS is constantly evolving its service offering to meet customer needs. Isolated Recovery, a recently introduced service, is one such example:

## **A successful recovery starts with clean backup data**

On average, cyberattacks can remain undetected for up to 99 days. This means there is the real prospect of an organisation having no clean backup data available with which to perform a recovery. To address this, Sungard

AS developed its Isolated Recovery solution for customers' critical applications that need an additional layer of protection.

Platform and operating system agnostic, this service enables customers to create a 'gold copy' of critical backup data in an Isolated Recovery vault in a separate, secure location. As data is replicated to the Isolated Recovery vault, customers can perform malware forensics and manage the risk of corruption.

Once the backup process is complete, the direct network connection to the Isolated Recovery vault is air-gapped or shut down. This isolates the gold copy from the network and prevents corruption. Organisations then have a safe backup to restore their data without fear of replicating the malware in the recovery process.

Lastly, because the Isolated Recovery vault stores multiple gold copies, all with retention lock, a rollback to days or weeks beforehand is possible if needed.

## **Council benefits from flexible, agile and resilient IT at lower cost**

Enfield Council was prompted to embark on a programme of digital transformation when its contract with an outsourcing provider came to a premature end. The forward-thinking local authority saw it as an opportunity



to grasp the flexibility and cost-savings achievable through exploiting cloud technologies. A seamless transition, with no degradation of services, was essential.

With the time being of the essence, the council turned to Sungard Availability Services, its longstanding disaster recovery provider, to guide it through a phased transformation programme. This involved helping the council transition to the Microsoft Azure cloud within an aggressive timescale and hosting remaining legacy systems in a secure, resilient environment. The migration was executed on time and within budget, so smoothly that those council employees were unaware that it had taken place!

Enfield Council is now benefiting from highly available and secure infrastructure with SLA-backed levels of uptime, lower IT running costs and greatly enhanced flexibility and scalability. As well as anticipated headline savings of 30%, it also has more predictable IT infrastructure spend with costs moving from the CapEx to OpEx budget and greater cost-effectiveness as it pays only for services used.

### **Government department retains control without the headaches**

Sungard AS also works with central government departments to achieve their 'cloud first' ambitions. One key department needed a cloud partner it could depend on to host four important applications and provide a disaster recovery service to minimise downtime.

It contracts Government Cloud Services from Sungard AS, which has been Cyber Essentials Plus-certified, via the Digital Marketplace. Under the G-Cloud call-off contract, Sungard AS provides the department with an enterprise-class, multi-tenancy, IT infrastructure in a secure hosted environment, resiliently connected. This means the department retains control over its all-important applications without the burden of owning and managing the underlying infrastructure. While this comes with the assurance of 99.99% uptime, the department contracts Cloud-Based Recovery to cover its hardware and operating system.

OFFICIAL data is hosted within two UK-based data centres, supported around-the-clock by a dedicated,

security-cleared operations team. In addition, the department can scale up quickly and easily according to demand.

Of course, some legacy systems are not suitable for the cloud so Sungard AS works with whatever infrastructure the organisation has, including the most complex Hybrid IT environments, providing comprehensive consultancy support.

To find out more about Sungard AS' services, call +44 (0)800 143 413 or email [Government@sungardas.com](mailto:Government@sungardas.com).





# Delivering effective digital services in an Agile way

Peter Stansbury introduces us to the new AgileDS (Agile Digital Services) guidance, published to support the Agile development and evolution of digital services

**W**e're living in an ever-changing and increasingly digital world which is having a significant impact on the ways in which organisations deliver services, and how consumers interact with those services.

To be successful, organisations need to be agile and able to react quickly to an ever-evolving business landscape and fierce competition.

And it's far from just the private sector; governments and local authorities have a great opportunity to embrace the shift to digital and revolutionize services they provide to citizens. From personalised services in health and social care for the elderly at home, to tailored learning in education and access to culture, the tools, techniques, technology and approaches of the internet age offer greater opportunities than ever before to improve services.

The UK Government is recognised as a world leader in digital government, led by the Government Digital Service (GDS) with its tenacious focus on user needs, common design principles, openness, balance between the needs of citizens and government... and Agility.

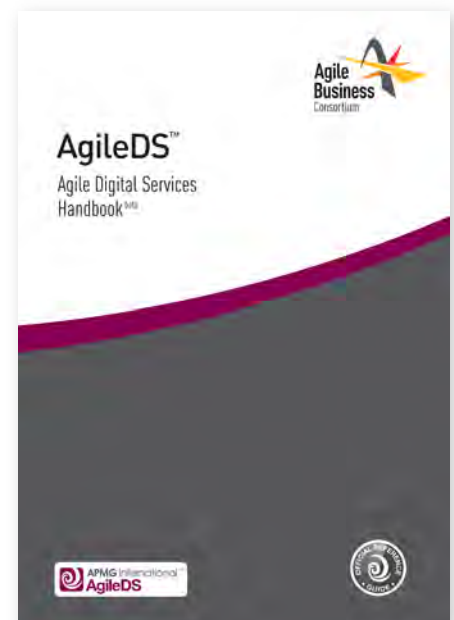
GDS was developed as part of a response to the situation where the UK Government's digital services initiatives were characterized by incon-



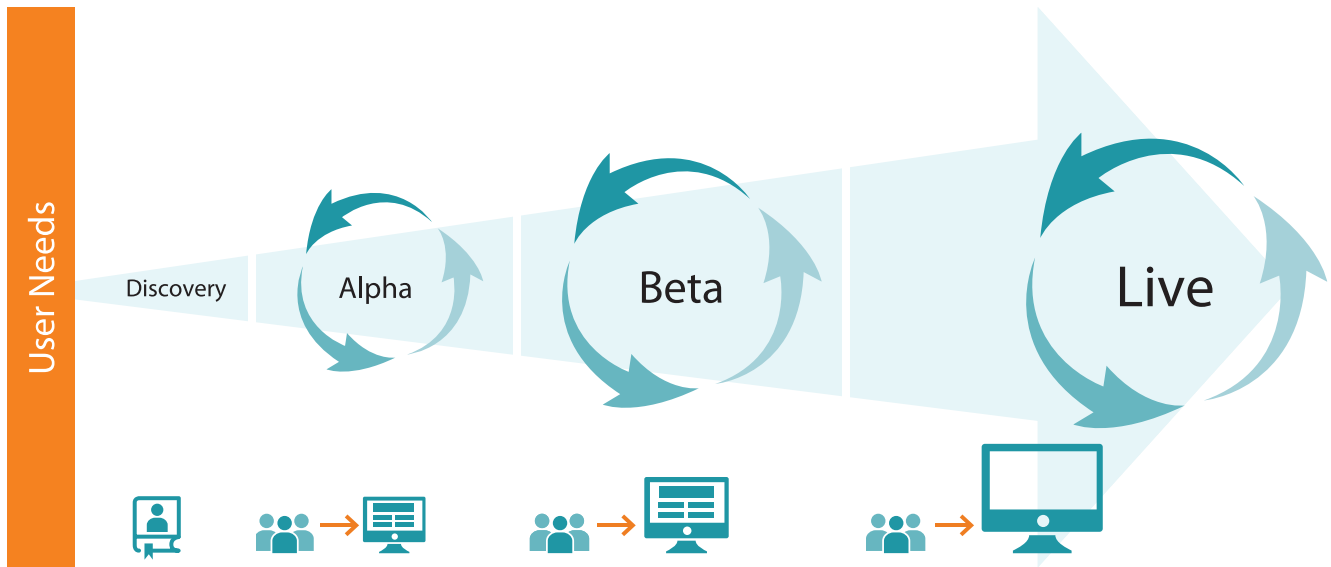
sistency, lack of maintenance and frequent reliance on big projects run by large suppliers resulting in cost overruns and late delivery.

In response to the special complexity of government, GDS has created the GOV.UK Service Standard and Supporting Service Manual, which defines a development lifecycle for digital services and provides standards and supporting guidance.

The UK Government's Digital Service Standard is focused on ensuring user needs are met. In fact, the Standard states "start with user needs" and "build services not websites" as two of its design principles, helping government create and run great digital services. The standard is well tried, shown to work, and drawing increasing attention from other countries.



The scale and complexity of public sector digital transformation is enormous. User research conducted by the Agile Business Consortium, talking to people working within government departments, found that people need



support and guidance to put the GOV.UK Service Manual into practice.

## AgileDS is that guidance.

The guidance is designed to support the Agile design and development of digital services. It enables organisations to develop a consistent approach, common language and skilled workforce for the successful design and delivery of digital services, whether through evolving improvements or step-change transformation.

AgileDS offers practitioners involved in the design and delivery of digital services with a mature Agile approach that embraces Agile product and service development in the context of Agile, business change-focused programmes and projects. The guidance has been designed carefully to use language familiar to public sector staff from the GDS Service Manual, including the GDS lifecycle (user-needs-discovery-alpha-beta-live) and GDS roles.

AgileDS helps practitioners to understand the:

- Underpinning philosophy and principles of Agile Digital Services in a project situation.

- Lifecycle of an Agile and Digital Services project.
- Effective application of key Agile techniques.
- Roles and responsibilities within an Agile Digital Services project.
- Mechanisms for planning, control and governance of an Agile Digital Services project.

AgileDS is aimed at all those involved in the delivery of digital services, including central government, local government, the NHS, and private sector organisations.

It's designed to be useful to all members of multidisciplinary service delivery teams and those who support them. For those with a good grasp of Agile methods, guidance on elements that might be new – such as user research, user experience design and digital performance analysis – are introduced. At the same time, the fundamentals of Agile culture and delivery are covered, as well as demystifying Agile jargon for civil servants and others who are new to Agile.

Alongside the new guidance, Foundation and Practitioner-level exams have been launched, administered by the award-winning examination institute APMG International.

Accredited training for AgileDS is available via a network of providers accredited by APMG International and the Agile Business Consortium.

Find out more about AgileDS at:

[www.agilebusiness.org/digital-services](http://www.agilebusiness.org/digital-services)

Find out more about AgileDS training and certification at:

[www.apmg-international.com/AgileDS](http://www.apmg-international.com/AgileDS)



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# Blockchain technology: Building the European Union's global leadership

Eva Kaili, MEP, Rapporteur of the European Parliament of the Blockchain Resolution explains the importance of building the European Union's global leadership where blockchain technology is concerned

Opening space for a new technology, like blockchain, in the political and regulatory level, is a challenging task. It looks like a political entrepreneurship endeavour. Governmental organisations always have their own priorities and their immediate needs to cover. Short-termism is the “by default” condition. Creating demand for political and regulatory engagement around a forward-looking and potentially disruptive technology is not always easy. Especially when this technology is in the middle of a hype, challenges the existing value chains and is depicted by many legacy institutions as barely legal or even a tool for scammers.

Having obtained the permission to write the Blockchain Resolution of the European Parliament the first priority was to start educating people that blockchain is a general purpose technology. Blockchain is not just about crypto-assets. It is an enabling technology that can be used in a wide range of sectors, including energy, supply chain management, education, creative industries, the financial sector, healthcare, transportation etc. The great achievement of the Blockchain Resolution is that depicts it as an infrastructure based on which we can develop smarter institutions, a more efficient public sector that increases the value to the citizens, and a solid foundation for the Internet of things (IoT) applications.

Of course, crypto-assets is a distinct enabling technology we cannot ignore. The difference between a cryptocurrency and an initial coin offering (ICO) is that the first has not a counterpart, whereas the second has. Regarding cryptocurrencies, Bitcoin, Ethereum (ETC) and so on and so forth, these provide us with an indicator for the evolution of money. The concept of money has

changed many times in the course of history. We are in a time of change once again. Eventually, we will be in need to have money that can be encoded in a smart contract. Cryptocurrencies can help in this direction. A “Crypto-Euro” is a case we should explore soon. On the other hand, ICOs proved that they are instruments that can mobilise idle capital in high-risk start-up projects. We touched on the issue during the negotiations of the Crowdfunding Platforms Regulation and we asked both the European Commission and The European Securities and Markets Authority (ESMA) to propose a framework that enables ICOs within a secure and legally-certain environment.

Another great challenge we stressed in the Blockchain Resolution of the European Parliament is about the development of an ecosystem that will support distributed ledger technology (DLT) in general. This challenge includes the problems of cybersecurity, data protection, energy waste problems, as well as issues about the interoperability of the ledgers, self-sovereignty and digital identity issues, and problems related to the legal enforceability of smart contracts. Especially in the space of smart contracts, the challenges are as great as their potential. Good governance methods and best practices can be explored through the thorough examination of use-cases and the development of blockchain application in the protected environment of regulatory sandboxes.

The European Commission has already built impressively on the mandate it took from the European Parliament. There are already four use-cases in place under the supervision of the Commission. There is also a hackathon of blockchain-based applications for social good that interested parties can apply for until





*Eva Kaili, MEP (S&D, Greece), Rapporteur of the European Parliament of the Blockchain Resolution*

April 2019. Use cases are the elements we need in order to promote blockchain technology and create certainty and confidence around it. Confidence building does not come from the regulation of the technology per se. It comes from the regulation of its uses. This is the regulatory concept of “technology neutrality”. The other regulatory concept we used is the “business model neutrality”. By this principle, we signify that the regulator does not favour any business model over another. If blockchain applications can disrupt existing value chains and replace them with brand new ones, then let it be so.

The most important thing though is to signify that blockchain is a technological space that the European Union (EU) can become a global leader in. Perhaps this

is the reason why all the political parties of the EU voted in favour of the resolution, something, which is a one-in-the-decade event in the Brussels politics. The European Commission is ready to move things forward fast and propose frameworks and initiatives that will strengthen the EU’s global competitive advantage in both standards-setting and ecosystem development. In this vein, we made sure that significant amounts of money will be dedicated to blockchain through the grants of the new Multiannual Financial Framework (MFF). Similarly, the European Investment Bank (EIB) and the European Investment Fund (EIF) will finance blockchain applications and research, either independently or within the framework of the European Fund for Strategic Investments (EFSI) and the InvestEU Programme.

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**“The European Commission has already built impressively on the mandate it took from the European Parliament. There are already four use-cases in place under the supervision of the Commission. There is also a hackathon of blockchain-based applications for social good that interested parties can apply for until April 2019. Use cases are the elements we need in order to promote blockchain technology and create certainty and confidence around it.”**

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It is apparent that the EU invests and opens up opportunities. It is now the decision of the European citizens, both start-ups, major firms, universities, research institutions and governmental organisations to start taking the risks of experimentation and develop commercial and non-commercial blockchain empowered solutions. Making the EU a global leader in the field, is essentially a bottom-up function and the success of the blockchain experiment can be copied to other technologies, that are even more complex, like artificial intelligence (AI), neuroscience and quantum computing. ■

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# A global biomedical ecosystem to underpin lifetime patient healthcare: Improving the world's supply chains

Genevieve Leveille, Venture Partner of BioLife and Co-Chair of the TechUK DLT Working Group explores how current advances in DLT will improve the world's biomedical supply chains when it comes to life sciences health care

**T**he way health services are delivered is changing and not a moment too soon for the world's ailing healthcare systems. Issues of patient data security, meeting agreed standards of healthcare and ensuring better health outcomes for all people everywhere have brought some of the brightest minds on the planet together at this crucial time, to solve the crisis. The BioLife team is at the forefront of the move toward lowering the costs of intricate care.

As BioLife begins to improve access to high-end biomedical services worldwide, there will be a noticeable shift in the way health is managed and treated. BioLife, through its digital ecosystem, integrates the world's major life science resources to underpin lifetime patient care and ensure global liquidity for the bioscience industry.

Yuelin Liu, Chairman of the Tinjoy Health Group, Executive Director of the China Overseas Chinese Merchants Association and Chairman of Shenzhen One Belt and One Road Investment Development Group started his business in 2007 and has made many advances in the life sciences industry including as the creator of BioLife.

Founded on digital ledger technology (DLT) as a consortium chain of ACChain,

BioLife digitises assets and handles private records for patients, investors and owners of global biomedical resources. Patients can create a personal electronic health record (EHR) and access high-end health product and service suppliers. Biomedical resources are digitised, and traceability is maintained throughout the supply chain as trade in digital assets between resource owners and patients takes place. Immutable peer-to-peer transactions occur on the BioLife chain when agreements trigger linked smart contracts.

These new technologies can support people in taking more responsibility for their own health. Waste is reduced within the system as biomedical resources are tracked end-to-end. Overall, the introduction of the BioLife ecosystem creates more productivity within the health systems of the world. Research and the development of new treatments are well supported through open sharing and better treatments without duplication can be produced faster. Treatments are becoming more personalised.

The BioLife platform serves as a safe, reliable, efficient and economical foundation for a thriving biosciences community. Products, services, personal data and assets relevant to life sciences health care are being

digitised. Patients can obtain authenticated pharmaceutical drugs and biomedical services and receive access to a credit ledger from asset owners.

BioLife providers include pharmaceutical companies, health service organisations, equipment manufacturers and research institutions. As patients purchase health services on the BioLife Service Platform, the relevant health data is accessed only through a private key and transmitted peer-to-peer, ensuring privacy and security.

As a decentralised healthcare delivery system, BioLife is poised with advantage in the coming establishment of widespread high-capacity, low-latency 5G networks planned for deployment in 2019. Early investors in the BioLife ecosystem will benefit from these deployments, which will support acceleration in the digitisation of distributed, local health resources worldwide.

The BioLife service platform opens a transparent marketplace for a wealth of customised biomedical treatments and therapies. BIOT, as the internal fuel token of BioLife, enables trade in biomedical resources as digital assets, reducing cross-border payment costs and risks. Contributors and investors are able to acquire, maintain and

## A Lifetime of Intricate Care in one Life Science Digital Ecosystem

access intricate health care within a safe and secure exchange system. BIOT is structured in a way that supports the entire BioLife digital ecosystem and increases liquidity within the biomedical industry.

The BioLife community is occupied by three types of members: clients (patients and their families), providers (health services practitioners, biomedical researchers, health service institutions, government agencies and non-profits), and developers (programmers and software engineers). As bioscience develops biological solutions to sustain, restore and improve quality of life for humans, plants and animals in our world, the BioLife community seeks to establish a service channel of traceability, security, convenience and confidentiality.

BioLife's resource providers include Swiss Serolab® of Leukerbad Wellness Management Group Ltd. The first enterprise to BioLife, Swiss Serolab® provides over 80 types of medicines and own more than 1,000 bioscience patents covering areas from anti-ageing to major illness precaution. Enshi Tinjoy Bio-Technology Co., Ltd., another resource provider on the BioLife chain, is a high-tech enterprise specialising in micro-ecological health. Shenzhen Dongchen Pharmaceutical Holdings Ltd., whose main business includes pharmaceutical precision retail, big data applications, health

management, and cross-border e-commerce of big health will integrate the chain pharmacy resources and adopt a model of "direct mining and self-operating + offline experience + health consultants" to provide clients with a number of value-added services. Guangzhou Zhongxin Gene Medical Technology Co., Ltd., a genetic wholly-owned enterprise with a mission to "take genetic technology as the core, with mobile intelligent monitoring of the Internet of things (IoT) platform to support and implement dynamic monitoring" is also among the first resource providers to join BioLife, with benefits to patients and the industry itself.

BioLife's resource providers include Swiss Serolab® of Leukerbad Wellness Management Group Ltd. The first enterprise to BioLife, Swiss Serolab® provide over 80 types of medicines and own more than 1,000 bioscience patents covering areas from anti-ageing to major illness precaution. Resource provider Enshi Tinjoy Bio-Technology Co., Ltd. is a high-tech enterprise specializing in micro-ecological health. Shenzhen Dongchen Pharmaceutical Holdings Ltd., whose main business includes pharmaceutical precision retail, big data applications, health management, and cross-border e-commerce of big health will provide clients with a number of value-added services. Guangzhou Zhongxin Gene Medical Technology Co., Ltd., a genetic wholly-owned enterprise with a mis-

sion to "take genetic technology as the core is also among the first resource providers to join BioLife, with benefits to patients and the industry itself.

As BioLife integrates our world's life science resources into one digital ecosystem, investors in BioLife have all the evidence of the value of their investments at their fingertips. It is time to reduce the costs of intricate care for Your Body, Your Health and Your Life.

### Social media links

<https://www.facebook.com/BioLifeChain/>

<https://t.me/BioLifecommunity>

<https://www.youtube.com/channel/UCI3azfNKsqHUythyOCSjxGA?v>

iew\_as=subscriber

<https://medium.com/biolife>

<https://www.reddit.com/r/BioLifeChain/>

<https://bitcointalk.org/index.php?topic=5065102.msg47675794>



### **Genevieve Leveille** **Venture Partner**

BioLife and Co-Chair of the TechUK DLT Working Group  
[www.biolifechain.io](http://www.biolifechain.io)



# Financial markets in Europe: Is it possible to avoid a crisis?

**Gunnar Hökmark MEP from the Group of the European People's Party (Christian Democrats) explores the world of financial markets in Europe and asks if it is possible to avoid a crisis. He also explains the potential impact of the role of disruptive change to new technologies on the market**

Is there a way to avoid a financial crisis? The answer is no. Financial crises will come, often as a result of high growth and rapid development. A disruptive change to new technologies may change the logic on the market and the game of competition or crises may suddenly emerge from financial instability, trade wars or conflicts. They can also come from misjudgements on the role of new or old business structures.

Bad investments have bad consequences and good investments will be followed by tougher times. When it happens, it influences financial markets, as financial markets measure the value and the development of the economy. That is how one can attract capital for investments, allocate it to the best investments and disinvest when needed. Financial capital decreases by losses and increases by profits.

The financial market is like a thermometer of the economy that sometimes goes better than expected and sometimes worse. Where there are growing economies and uncertainty about the future, there can be a crisis. Uncertainties in the short-run secure growth and prosperity in the long-run. Only failed economies avoid financial crises, because of constant stagnation without hope for new achievements. We cannot avoid crises, but we can reduce the magnitude and the consequences.

First, we need financial markets in competition, which can serve different technologies and business models. That is why it is important with a European financial market, to have a Capital Markets Union and competition. With the plurality of business ideas, different technologies, companies to invest in and private investors, we get tremendous risk sharing. There will still be defaults and insolvencies, but most of them will not influence other parts of the economy.

Financial markets are about analysing risks, taking risks and distributing them. Better opportunities to analyse risks means better risks will be taken. The more different the risks are, the better they are distributed.

Second, we need different investors. Capital markets union is of interest for anyone who wants to stimulate investments together with stable financial markets. The more capital for investments outside the banking sector, the less exposure for the banking sector to risks of the economy. We need to stimulate private shareholding, private equity, different forms of venture capital and private savings. When private households have better buffers for losses, they have better room for new investments, and stability.

Third, financial markets must be characterised by transparency and efforts directed to the best of the investors, savers or customers. Customers and investors need to know the risks. Investment companies need to serve the interests of the customers to facilitate profits to the company and the leadership. We have made progress in this context via the legislation on Mifid, IDD and Emir.

Fourth, banks need to be as stable as possible. They are the core of financial markets, necessary for payments, saving, investment making, liquidity making and financing investments. In Europe, they are financing the dominating part of small and medium-sized companies. We must ensure that they are not overburdened, unable to finance necessary investments, which would lead to financial instability when companies fail to grow.

It is good if banks can be based on different legs, like investment making, market maker trading, or their customers but not on their own interest, retail and



*Gunnar Hökmark MEP, Group of the European People's Party (Christian Democrats)*

deposit. Diversified banks normally seem bigger, but also more stable. That is why I opposed the proposed legislation on separating banks in two parts: retail and the rest. It would have hindered development to a better capital market, but also competitiveness on the global market, and reduced investment and market making where it is needed.

Now we are strengthening the credibility of dealing with banks in crises through the banking recovery and resolution directive (BRRD), which is the base of the banking union. We are introducing requirements on subordinated capital that will facilitate bail-in without rocking the financial system or public finances. With higher levels of own capital and sufficient debt for bail, we clarify that banks are exposed to risks just as every other company, meaning that risks in banks will be analysed and distributed the same as financial markets in other parts of the economy. Those who invest in the bank will pay for losses and deficits and will refrain from investing more than they can lose.

Fifth, public finances must be stable and on EU-level. We need a backstop in the form of European Stability

Mechanism (ESM) that can stabilise banks when a bail-in is not enough and can lead to deeper crises. The ESM is important to make the bail-in instrument in the BRRD credible, meaning that markets know that bail-in will be used because governments have other alternatives if the situation becomes worse.

These five points make risks in the financial markets better analysed, taken by those who can take risks and distributed to avoid deep shock. This way we can reduce the impact of a crisis and prepare for new opportunities. ■

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# Bridging the gap between traditional banking and crypto

The Founder and CEO of HEdpAY reveals his ultimate vision to be the leading company in FinTech by bridging the gap between the traditional financial services and the crypto ecosystem in today's global market

Whilst some people still 'trust' traditional banks and financial institutions, many are looking to a new world – and this includes cryptocurrencies and crypto banking. Vicken Kaprelian, Founder and CEO of HEdpAY, a pioneering company in connecting traditional banking and the crypto universe, talks about his ultimate vision to be the leading company in FinTech bridging the gap between the traditional financial services and the crypto ecosystem in the global market.

"Unlike traditional money, crypto is decentralised, meaning it is outside the control of banks," explains Vicken. "The banks have, therefore, largely shunned crypto, particularly as it is also coming under increasing scrutiny from regulators. For crypto to be used by the masses, it currently must be integrated with fiat currency (euros, pounds, dollars, etc). Both traditional banks and crypto banks have their place, and, with the current mood of distrust, they need each other. There is a bridge that needs to be built to align both." Future banking operators like HEdpAY are building a platform that connects crypto with fiat currencies and supports decentralised control. Overcoming these challenges will finally bring crypto use to the mass market.

"Traditional banks are seeing the potential value of crypto but bringing

them together requires restructuring of legacy systems, adaption to the desires of the new consumer generation and changes to rules and regulations," continues Vicken. "Banks and bankers' worst clients are high-risk customers and non-stable residents, but the red-tape around compliance and KYC procedures are really due to human constraints, however, cryptocurrencies and blockchain solutions embrace a self-centralised process in a smart contract manner. I believe we will see more of a correlation between fiat and crypto, with banks and ICOs creating their own blockchain platforms and bespoke tokens, which will, in turn, become the new bank currencies. Consumers will then use these widely more for payments but in a decentralised way, just managed by the bank on their behalf.

HEdpAY is one of the first projects connecting traditional bank and the crypto universe, and one of the first to be creating investment funds in crypto, in order to maximise profits and minimise losses," explains Vicken. It has been created to be the first and most authoritative financial institution enabling users to transfer their fiat currency in crypto quickly, safely and compliantly, using the following services: current account, debit card and exchange. HEdpAY also gives investors exclusive opportunities: creating their own blockchain, helping entrepreneurs developing new projects

(ICO) following detailed protocols, selecting only the best projects in order to preserve investors, and evaluating currencies already included in the market.

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**"Overcoming these challenges will finally bring crypto to the mass market".**

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The company's goal is to showcase how its futuristic solution, "bridges the gap between crypto and traditional banking to revolutionise a financial system that is still anchored to old banking standards," in the words of Vicken. He believes that the real opportunity is the benefits blockchain can bring to the financial services industry. "While ICO marketing has witnessed saturation over the past few months, the real opportunity is more about the benefits that blockchain can bring to financial services to bridge the gap between traditional and crypto banks. The insurance industry is primed for the integration of blockchain technologies. Other opportunities can be seen in voting, forecasting, government, crowdfunding, retail and real estate. I think the possibilities are endless.

Despite the perceived negativity around cryptocurrencies in regard to the puzzle of jurisdictional risk and regulation, Vicken is positive about the future of crypto, whilst establishing and cultivating compliant relationships





with the regulatory bodies, global financial institutions and businesses. "HEdpAY's purpose is to provide the services of the modern traditional bank whilst implementing the prospects of a bank for cryptocurrencies, and at the same time ensuring better regulation of the cryptocurrency market, says Vicken."

**"...revolutionise a financial system that is still anchored to old banking standards."**

In the past year, HEdpAY has reached some significant milestones, most recently the company received the Most Outstanding Payments Solution Company of the Year 2018 in the Global Business Insight Awards and has been listed on four major crypto exchanges including ChainCreator. The company offers two kinds of HEdpAY (Hdp.dp) ERC223 tokens:

- Equity token, based on the company equity, hedged to the registrar of its c-class shares, which will be presented in Q1 2019 and;
- Utility token, based on the community operations and transaction activities, which will be available until the end of Q4 2018.

"Both tokens will be used within the HEdpAY ecosystem to ensure our team of highly skilled developers to complete development work on our revolutionary platform, adds Vicken."

### **HEdpAY's ambitions of the future**

Going forward, the company's ambition remains undimmed. "HEdpAY has an exciting year ahead in terms of the completion of our ICO, the future launch of the HEdpAY Exchange and

our full set of banking services," says Kaprelian. "In a year's time, I would like to see the gap between traditional and crypto banking reduced thanks to the wider benefits that can be realised through blockchain technology."

HEdpAY – The future banking solution. Explore the possibilities?



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# Decentralising security for mobile devices: Is blockchain the viable solution?

Steven Sprague, Cofounder and CEO of Rivetz reveals a viable solution when it comes to decentralising security. He argues that there is great promise for creating mobile device security with blockchain technology

The world was introduced to the first commercial mobile phone in 1983 with the launch of the Motorola DynaTAC 800x, which stood at a height of 13 inches, weighed 1.75 pounds and took 10 hours to recharge. In the early days of the mobile phone industry, it was incredibly simple for attackers to clone a phone's identity and run up all sorts of charges on your account.

Over the last few decades, mobile has experienced quite a metamorphosis from the "brick" of the 1980s to the compact, feature-packed smartphone of today. Now, mobile is king – people across the globe use their mobile devices not only to communicate but also to read the news, get directions, stream music, check bank accounts, store assets and so much more.

As we increasingly rely on our mobile devices, new avenues of attack continue to emerge. So much of our sensitive personal information and digital assets – such as corporate data and bank account and credit card numbers – are accessible via our mobile devices. They have become treasure troves for attackers.

## Blockchain and mobile device security

There is great promise for creating mobile device security by combining secure enclaves – also known as 'roots

of trust' – with blockchain technology. Blockchain is a distributed ledger technology that protects a digital transaction through complex mathematical algorithms. Because of the strength of this math, the transaction can only be created by those who hold a valid private key.

Private keys were developed as a means of protecting our digital transactions. A private key is a piece of cryptographic code that allows a user to prove who he or she is – in other words, it's a digital signature that says the user is, in fact, the one who is executing a digital transaction.

Private keys are used to secure a variety of transactions on mobile, including messaging, cryptocurrency and more. Here's the downside: if an attacker steals your private key, they can impersonate you, and then access and abuse your data and digital assets. The prevalence of mobile devices has made them some of the largest repositories for private keys.

The biggest challenge in decentralised cybersecurity is that we cannot prove the transaction was intended. If an attacker steals your private key and transfers \$5,000 to a third person, there is no way to prove that the attacker – and not you – performed the transaction. Rivetz ensures an intended transaction by establishing

that it occurs from a known device, in a known condition, with an authorised user, under the required conditions. Rivetz performs "device attestation" to ensure a user's devices are in a "known" condition by executing regular health checks to ensure the device integrity. Each device's integrity is recorded on the blockchain so future health checks can be compared with the baseline, establishing that those devices are in a condition the user intended.

As the rise of the internet brought digital fraud and attacks on identity, innovative industry leaders banded together to fight that fraud and formed organisations such as the Trusted Computing Group (TCG). TCG developed specifications that have become standard for securing devices, as well as the data and identity on those devices, such as personal computers and laptops.

Trusted computing uses hardware to protect users. It ensures a device will consistently behave in the expected ways, protected by a secure enclave or a 'root of trust' embedded within the device's hardware. A root of trust is isolated from the device's software operating system (OS), allowing it to execute code that cannot be seen by the OS. One such root of trust developed by Global Platform is the Trusted Execution Environment (TEE), which



enables trusted computing technology for mobile devices. The TEE already is built into the hardware of more than 1 billion mobile devices. Today, most private keys are generated within software, which is much more susceptible to attack than hardware. The TEE is capable of protecting a user's private key within the device hardware, a method that is far more secure than performing these operations in standard software.

A single system of security may not be enough to protect against the variety of cyber-attacks possible today. It is more pressing than ever to provide multi-layered protection of digital assets across two or more security domains. That way, even if an attacker were to breach one point of security, the other(s) still would need to be compromised, offering an extra layer of protection for important digital assets – whether that's your personal information or your hard-earned money.

One of the most ubiquitous roots of trust is the subscriber identity module, or SIM card. The SIM is a protected hardware environment and was created to combat mobile fraud and to protect the device identity. With the pervasiveness of both the TEE and the SIM, Rivetz saw an innovative opportunity to use these isolated roots of trust to work together to protect mobile users. In conjunction

with ElevenPaths, the cybersecurity unit of Telefónica, the world's third-largest mobile carrier with more than 300 million subscribers, Rivetz uses both the TEE and SIM to protect our private keys – introducing the Dual Roots of Trust.

The solution leverages the TEE along with the SIMs deployed by Telefónica. With Dual Roots of Trust, Rivetz-enabled apps generate private keys in hardware, then cryptographically distribute those private keys between the TEE and the SIM. This delivers built-in security from both the mobile carrier and the device manufacturers, to create decentralised key protection.

By distributing a private key across these two roots of trust, attackers would have to breach both secure systems in order to steal a single private key. As an added security feature, two different entities – or independent control planes – aid the user in controlling their private keys. Through a special application authorised to perform activities inside the TEE, the user remains in control of the secrets stored in the TEE. If your mobile device is lost or stolen, a simple interaction with your mobile carrier can disable the SIM, permanently or temporarily until the device is found. So even if a thief has your device, you remain in control and your private keys are still safe.

The Rivetz solution has an unlimited number of use cases, such as sensitive work apps, mobile wallets, social media accounts and mobile banking. One of the most unique applications of Dual Roots of Trust is the ability to provably control specific applications on a device. This feature is especially useful for enterprises. Let's say a company has its own proprietary Rivetz-enabled app that employees use for work on their personal devices. If an employee is terminated or leaves, the company has the ability to revoke access to that app on the former employee's personal device with Dual Roots of Trust.

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 solution lies in the roots of trust that already exist on millions of mobile platforms: the SIM and the TEE are two of the most common secure enclaves. Dual Roots of Trust is the next step in ensuring our assets stay safe.



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# A blockchain-based governance model for public services in smart cities

Stefan Junestrand, CEO of Grupo Tecma Red and a member of the European Blockchain Observatory shares his thoughts on what a blockchain-based governance model for smart cities looks like

**B**lockchain is a technology that has revolutionised the world of finance through cryptocurrencies. Now, the turn has come for blockchain to transform other fundamental aspects of our society, such as the organisation of businesses, the ownership of assets and even the way in which we govern our societies.

This opportunity for blockchain arises in an era where the management and services of our cities are being digitalised and are developing towards what is called “smart cities”. It also comes at a time when public administrations all over the world are facing a growing demand to fight corruption; to improve the efficiency, transparency and security of their systems; and to develop a more participative, interactive and democratic citizenship.

Existing organisational models and technology platforms have not been able to provide all of the abovementioned needs. Blockchain technology, though, could offer solutions for the improvement of many of these aspects since one of its main features is that it provides a transparent, neutral, non-hierarchical, accessible, non-manipulable and secure information platform. Blockchain is also especially suitable for environments where there is low trust established between the actors, which is the case of the governance of our cities.

As a proof of the increasing interest in the use of blockchain for public services, many cities around the world have started to experiment with the development of blockchain applications. That work is of great importance since it generates experience and knowledge. But almost all blockchain applications currently developed, are isolated and hardly any city has a clear strategy on how to integrate them within a complete blockchain-based governance model for public services.



*Stefan Junestrand, PhD Architect*

The aim of this article is to help cities around the world to understand the framework, as well as the different components and their functionalities in a fully developed blockchain-based governance model for public services in smart cities. In this way, it will be easier to avoid unnecessary mistakes and get on the right track from the beginning.

This article starts with an introduction of the blockchain technology itself, as well as the phenomenon of smart cities. After that, it analyses how these two concepts can work together and presents a blockchain-based governance model for public services in smart cities. It concludes with some practical recommendations for cities in their approach to blockchain projects, along with a discussion of potential future research.

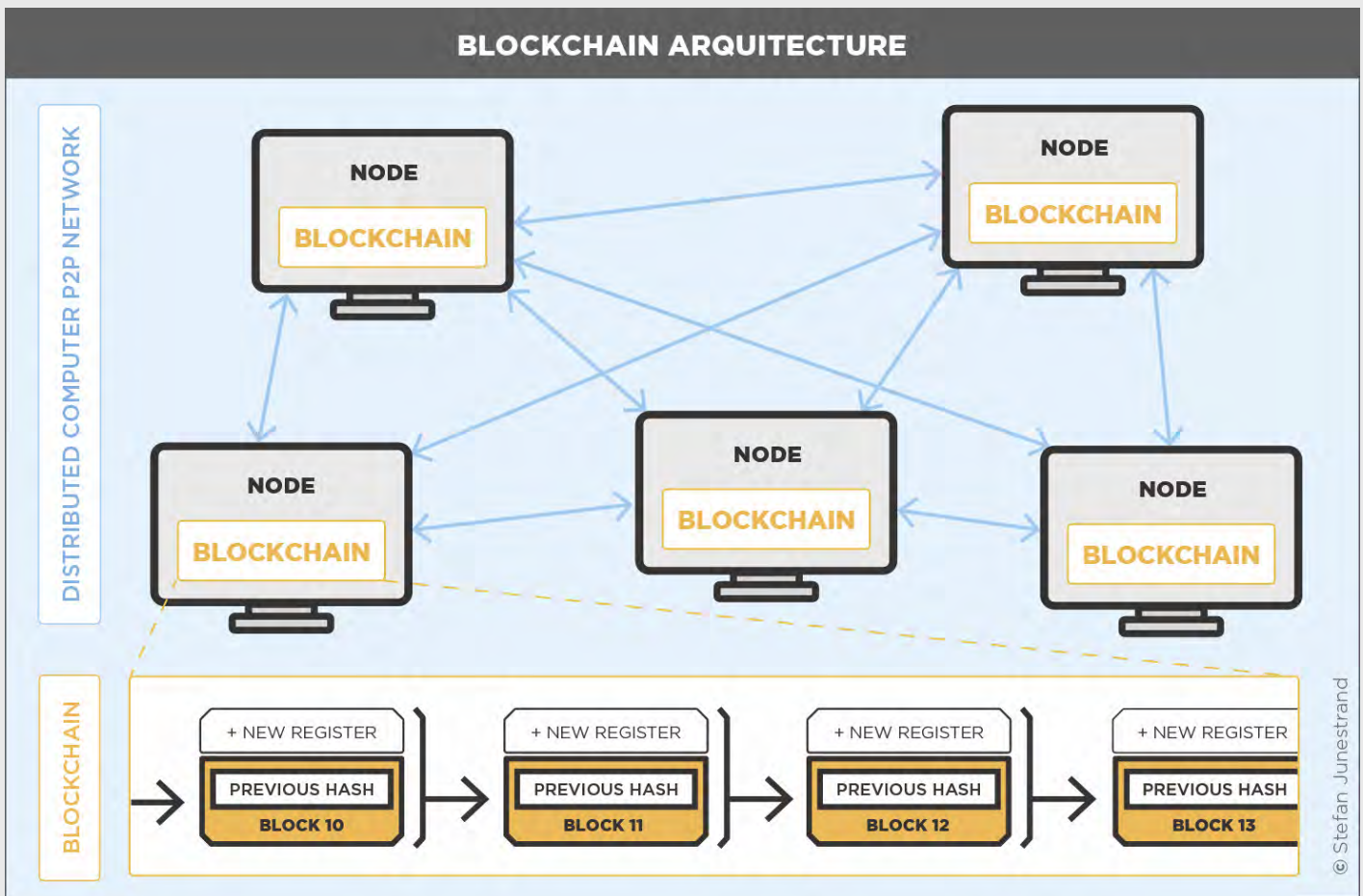


Figure 1. Model of the blockchain architecture with its principal elements. (Source: Stefan Junestrand)

It is worth pointing out that the political responsibilities for cities vary enormously around the world. And this article has a very open approach to this fact, as it considers that the city government could potentially provide almost any sort of public service in areas like administration, education, health, social services, transportation, security, energy, telecommunication, urban planning, waste management, etc.

## What is blockchain?

Blockchain is a decentralised registry distributed on a computer network, where each computer stores the same information. On public blockchains, the information and functionality is owned and controlled by the members of the network and not by a central entity. The members of the blockchain system can add new information, but the previous records cannot be modified. The information can also be made public for any user to read.

Blockchain is designed to offer a secure, immutable and transparent information management platform

for almost any application and it is especially relevant in environments where there is a lack of trust between the actors.

Figure 1 shows a blockchain architecture, with the distributed peer-to-peer (P2P) computer network in which interconnected nodes ("peers") share resources amongst each other without the use of a centralised administrative system, and each node has a shared version of the blockchain. For every new register a new block is created, adding the new register to the previous information, which is then updated on the whole network.

## Distributed ledger technologies

It is important to understand that there is not only one blockchain, nor one single blockchain technology, but that the use of the concept blockchain, on a daily basis, refers to what is called distributed ledger technologies (DLTs). Ledger relates here to the traditional book of accounting where all the economic movements of an organisational entity (company, public administration, etc.) are recorded in chronological order.

Nowadays, the use of blockchain is not limited to economic transactions, but it is also used to record any “event” that occurs and that we want to keep a record of, for example: the transfer of properties, weather conditions, gaming results or medical history.

## Smart contracts

The second generation of blockchain offers additional functionality to the pure recording of data, which is called “smart contracts”. Smart contracts allow the blockchain to be programmed for automatic actions of any kind, triggered by any external action, based upon simple conditional statements.

## DAPPS

A Dapp is a blockchain enabled web application, although in blockchain, the applications aren't called Apps, but “Dapps” (decentralised applications). This refers to that, the blockchain applications are run on a decentralised network. The Dapps are built upon the smart contract and use tokens for the transactions within the application and can also use them to reward users that provide computing power to the network.

## Tokens

In blockchain systems, “tokens” are the representation of the different values and are the components used for the transactions within the system. Tokens can be of many types, but what they have in common is that they serve as an identifier for any kind of digital asset, which could be anything from monetary (as in cryptocurrencies) to physical assets (such as a piece of land) and even voting rights in a company, a private club, or a public election, etc. The tokens are technically a digital series of encrypted numbers (called a hash) which are stored by the users in their digital wallet and can only be used by accessing that wallet.

## What makes blockchain different?

The main aspects that make blockchain so interesting and different from other database solutions are the following:

**Decentralised ownership:** Instead of a centralised database, a blockchain uses many decentralised, distributed and replicated databases in a computer network. This decentralised architecture establishes the ownership of the network to the users and not to a centralised organisation.

**Immutability:** Data storage is done in “blocks”, which are linked together in chronological order, generating a “chain” of “blocks”, i.e. blockchain. These blocks are added using complex cryptographical methods, a process called mining. The changes made are also registered simultaneously in all databases. Hence, in the blockchain, you cannot change a block in the chain, only add new blocks. This means that it is impossible to change the history of records in a blockchain, it is immutable.

**Cybersecurity:** The decentralised architecture, combined with the information stored in “chains” of “blocks” using complex cryptography, is a combination that makes a blockchain almost impossible to hack or attack from a cybersecurity point of view.

## Different setups of blockchains

As mentioned above, blockchain is a flexible technology and can be applied in many different ways. When a blockchain is set-up and depending upon the needs of each application, there are two essential characteristics to consider:

**Public and private blockchains:** A blockchain can be both public and private, as well as a hybrid between both. In a public blockchain (also called permission-less), anyone can join by setting up a copy of the database and participating, but in a private blockchain, the owners of the application decide who may join the network and participate actively on it.

**Rights to read and write:** Another aspect to define is who has the right to read the data, as well as who has the right to add data to the databases. For example, in a city that uses blockchain for their financial ledgers, the city administration should probably be the only one able to write new data, although any citizen should be able to read all the information.

## Towards smart cities

There is a growing need to tackle a number of organisational and social issues related to our cities today. Some of the most prominent trends and tendencies related to the cities are:

- The cities themselves are a force to attract an ever-increasing part of the population. In 2014, 54% of the world population was located in urban areas,



a percentage that is growing continuously and is expected to reach 66% by 2050 <sup>(1)</sup>.

- The cities are playing a more prominent role in the economy and welfare of the nations. Although, our cities are also a focus for administrative, organisational, logistical, social and environmental problems.
- New political and social trends are claiming changes, such as: the end of corruption; greater transparency; the improvement of administrative efficiency; new models for citizen participation; more and better access to information and; better protection of personal and public information from a cybersecurity perspective, etc.
- Environmental related issues are playing a critical role in the cities with demand for lower energy consumption, less polluted air, etc.
- The technological development in areas such as communication, informatics and robotics is enormous <sup>(2)</sup> and society today is developing towards what is called a hyper-connected information society <sup>(3)</sup>.

In response to the above challenges and new needs, the only reasonable solution is to incorporate technology to a higher degree in the management and operation of our cities. The concept that refers to an integrated and fully deployed use of information and communication technologies in the management of the cities is called “smart cities”.

Given this background, it is understandable that there exists a growing interest in this topic and that large investments are being made in turning cities around the world into smart cities. For example, China is developing more than 200 smart cities <sup>(4)</sup>, India is including more than 100 cities in the “Smart Cities Mission” <sup>(5)</sup>; the U.S. has developed the “Smart Cities Initiative” <sup>(6)</sup>; and Spain promotes the “National Smart Cities Plan” <sup>(7)</sup>.

### Smart city platforms

Until a few years ago, the process of digitalisation and automation of public services was stuck in the improvement of each service in an isolated way. But this limitation is no longer necessary since the different services in a city now can be integrated with each other. The technological solution that offers a horizontal

integration of the different public services are called “smart city platforms”. The platforms provide a single interface for the management of the whole city, which makes our cities capable of providing a radically more efficient type of management, as well as new and better services towards its citizens.

Smart city platforms are developed both by private companies and public collaborative initiatives and are implemented and used in a large number of cities around the world. Although the technical functionalities of current smart city platforms are generally good, many are still closed systems that show difficulties related to integration, transparency, security and robustness.

A possible solution to these problems presented is to build the smart city platforms upon blockchain technology. A correctly implemented smart city blockchain platform has the potential to revolutionise the governance model of the cities and provide a truly immutable, secure, open and transparent system for the citizens and the companies that operate within it. Below, the design of a “blockchain-based smart city governance platform for public services” is presented.

### The design of a blockchain-based smart city governance model for public services

Applying blockchain for isolated services can be relatively easy and straightforward both within the private and the public sector. Nevertheless, it becomes more complex when it comes to using blockchain as a governance platform for the public services in an entire smart city. In this case, the whole governance model has to be designed to permit the implementation of political goals through the blockchain system. The main question then becomes:

- What should the organisation of a blockchain-based smart city governance model for public services look like?

Also, many other key questions arise concerning the model, such as:

- In what way can the different public blockchain-based services be best integrated with each other?
- How can private, or semi-public, blockchain services

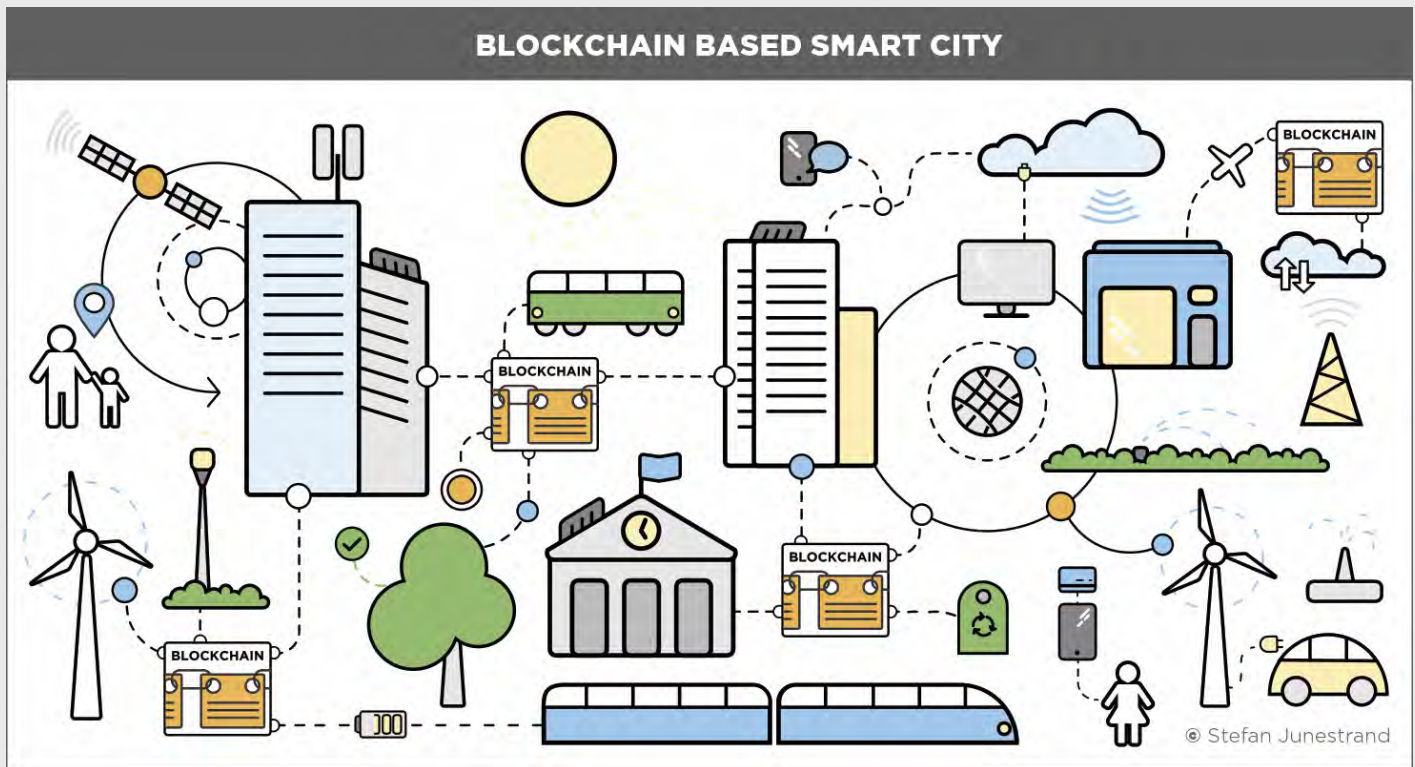


Figure 2. A smart city based upon blockchain. (Source: Stefan Junestrand)

be integrated with public blockchain-based services?

- Shall the public administration use one single token, or should a different token be used for each service?
- How can both private and open data within the system be structured, regulated and controlled?

Below, a model of a blockchain-based smart city governance platform for public services is presented, together with a discussion and presentation of some tentative answers to the questions above.

## The components of the model

In a smart city governance platform for public services structured upon blockchain, some unique components such as: the digital wallet, Dapps, tokens, etc. are introduced, which are not present in governance models without blockchain.

Hence, to build a model for blockchain-based governance of public services in smart cities, the first step is to ensure that the main components are included and furthermore, that they are structured and organised in a relevant way, with a description of their functionalities.

The main components of the proposed model and their basic functionalities are:

- **Users:** Anybody with a relation to the public administration such as inhabitants, companies, institutions, etc..
- **User interfaces:** The interfaces through which the users interact with the different Dapps and information.
- **Digital ID:** The way the end user is identified within the system.
- **Open Data:** The information in the system that can be accessed by any person or system, such as public finances and records, voting results, urban data, environmental data, etc.
- **Digital Wallet:** The place where the users store their tokens (resources).
- **Tokens:** The units of value that represent different "rights", such as specific tokens for voting, health services, education, transportation, etc.

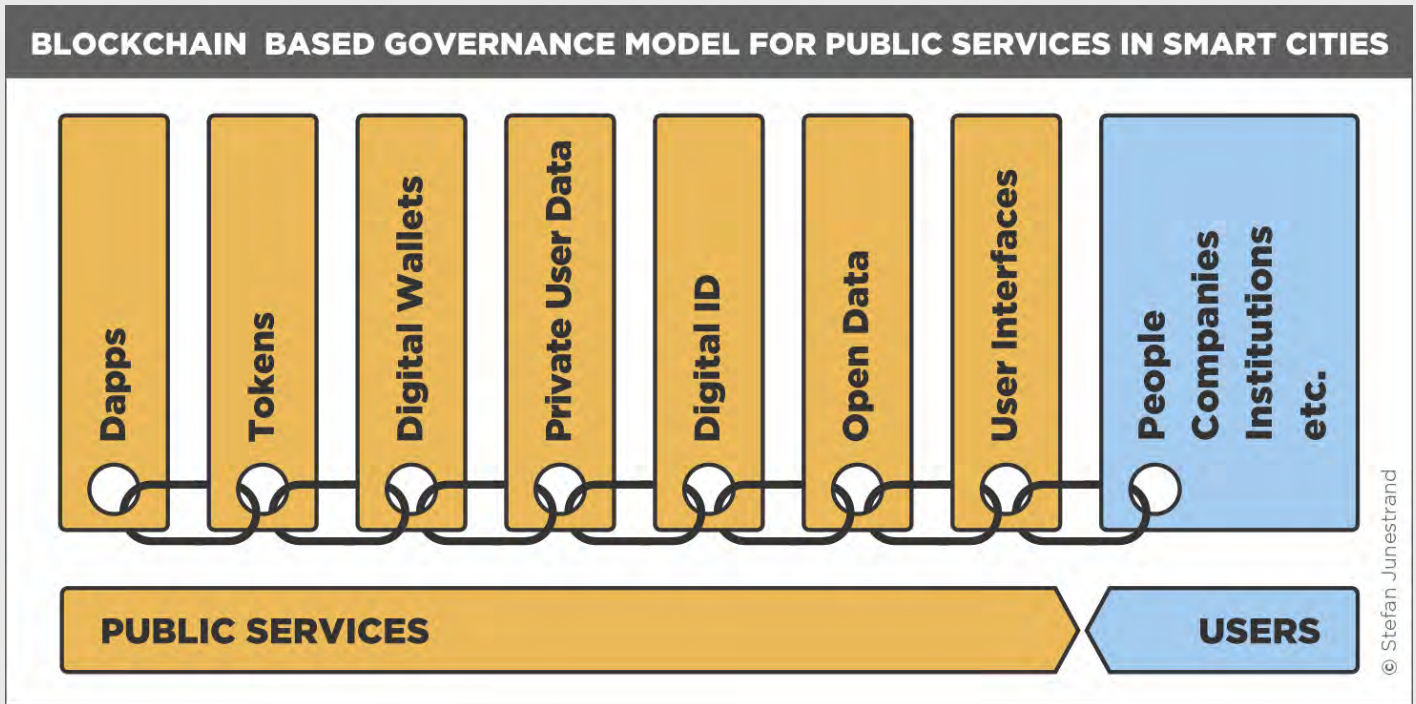


Figure 3. A blockchain-based governance model for public services in smart cities. (Source: Stefan Junestrand)

- **Dapps:** The distributed web applications developed for the implementation and management of the public services.
- **Public services:** The governmental activities from where the services are provided through the Dapps, and tokens and from where the private user data and the open data is delivered.
- **Private user data:** The information only accessible to the users with the specific rights, such as health records, social data, etc.

By structuring these components, a blockchain-based governance model for public services in smart cities is built (see fig. 3).

## Reflections over the proposed blockchain based governance model for smart cities

Some general conclusions and discussions can be established when analysing the presented “blockchain based governance model for public services in smart cities” (see fig. 3):

- The “user interfaces” is the citizens first step towards

any interaction with the applications and information. The design has to ensure the widest acceptance possible within the population, offering a variety of technology platform preferences, such as mobile, PC, etc. as well as the application of an accessible design considering different physical and intellectual capacities.

- The role of the “Digital ID” can’t be overestimated, as it is necessary for any personalised interaction with the system, hence a successful deployment of a blockchain based governance model also has to ensure widespread implementation of the digital ID.
- The blockchain based governance model for smart cities will change existing tools and mechanisms for political steering, leaving public services to be implemented mainly through the Dapps, which will be the primary channel for the different services provided by a city.
- The development of specific tokens, in combination with the design of the Dappss, can ensure a high level of accuracy in the implementation of the public services.



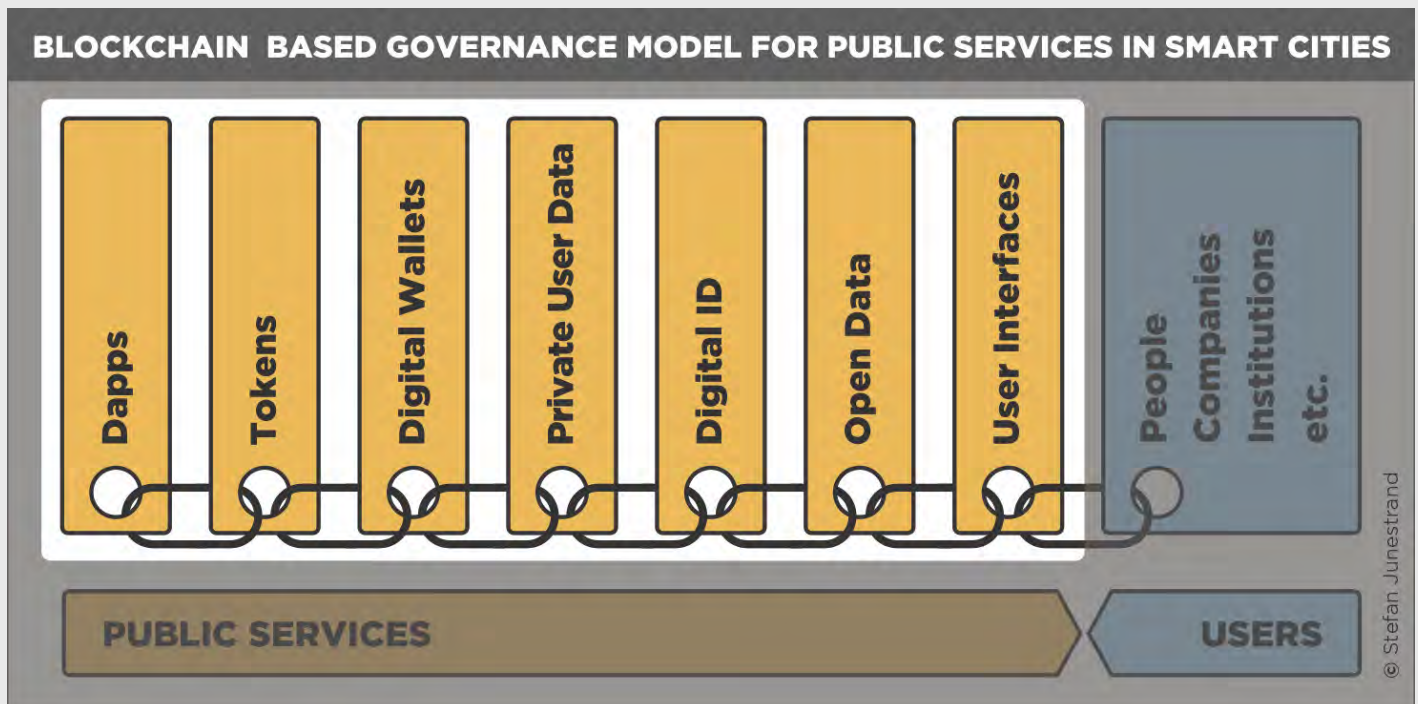


Figure 4. Illustration of the areas involved in a full scale interactive service Dapp within the blockchain-based governance model for public services in smart cities. (Source: Stefan Junestrand)

- All public services do not necessarily include the interaction with the end user, for example, the financial information of a city could be a simple informative public ledger Dapp.
- All public services do not provide both private user data and open data, as this depends upon the information related to the service that is desired to be shared.
- In a blockchain based governance model for smart cities, it is also crucial to establish which parts of the blockchain should be public, private or a mix of both.

## Final discussion

This article points out that a blockchain based governance model for public services in smart cities is necessary to understand the broader context of both current blockchain based public service projects, as well as future developments. Below, are recommendations for these implementations along with some important questions to be considered for future research.

## Recommendations for the implementation of blockchain based public services

Most cities that consider experimenting with blockchain technology for their public services will probably take

a step by step approach, starting with isolated, small-scale pilot projects. When doing this, it is important though to understand the consequences of choosing which project to do, as some are more complex than others. Here are two examples:

The first is the development of a full scale interactive service Dapp, that generally implicates the use of many components within the model, such as the digital ID, a token, the wallet, etc. which results in a complex project (see fig. 4).

The second example is using blockchain only as a registry for public information which might be rather simple and involves few, and less complex, components within the model (see fig. 5).

To conclude, two main recommendations can be made for cities, either they are taking the first experimental steps with blockchain or advancing towards more complex services:

- As a starting point, it's essential for each city to develop their own governance model for public services based upon blockchain.
- It is important to describe how each project could fit

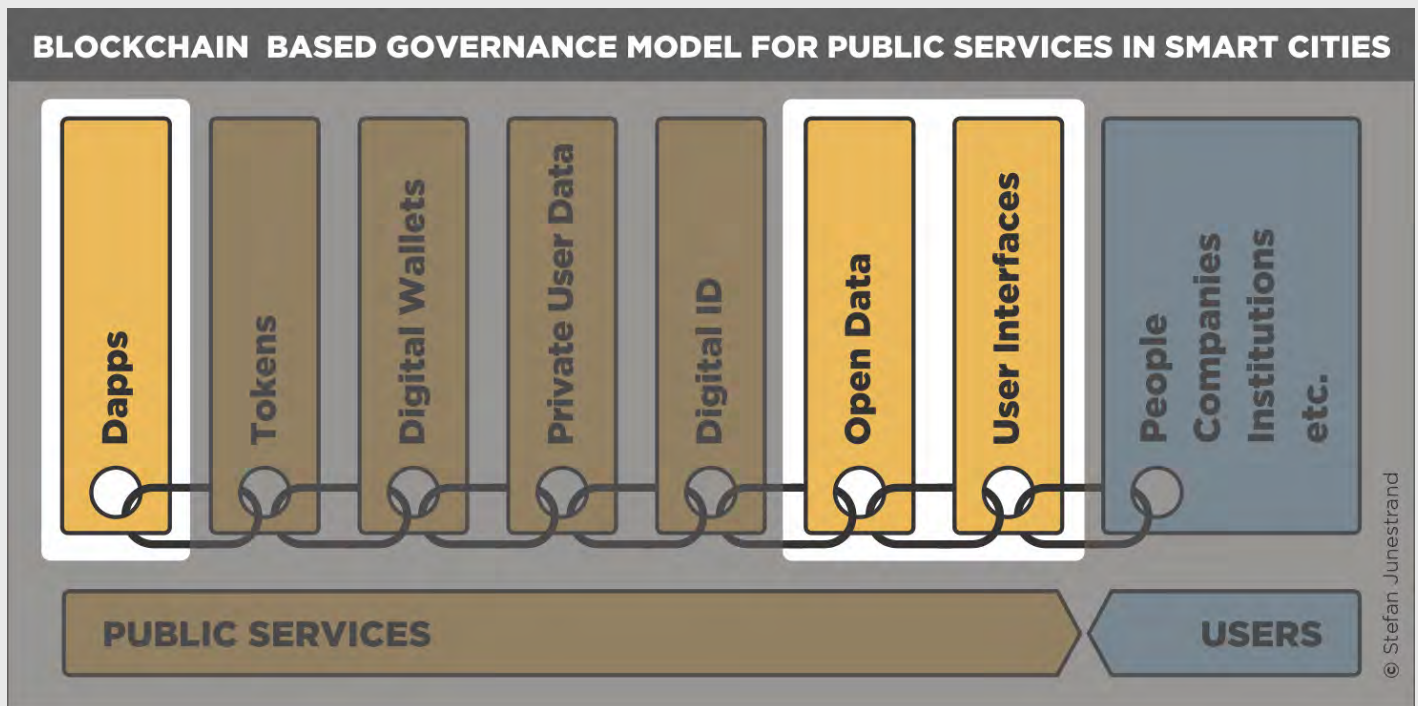


Figure 5. Illustration of the areas involved when using blockchain as a simple registry within the blockchain-based governance model for public services in smart cities. (Source: Stefan Junestrand)

into the cities complete blockchain base governance model for public services based upon blockchain and the components involved in the development.

- It is important to select blockchain projects that match the available human resources, budget, time-frame, etc.

## Future research

Below some recommended general research activities that could be of special interest to improve the proposed blockchain-based governance model for public services in smart cities:

- Further analyse the different components of the model and how they are interconnected, as well as the role and functionality of each one of them.
- Study real life blockchain-based public service projects in cities and compare those with the model.
- Evaluate the model from technical, legal, social and economic perspectives. ■

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# Distributed technologies to bootstrap the sharing economy

Professor Samer Hassan, explores how blockchain has the potential to help sharing economy projects to overcome several challenges they face at infrastructure, governance and economic levels

**T**he sharing economy has experienced significant growth in recent years and is estimated to reach \$300 billion in 2025. This growth has been accompanied by a number of challenges at different levels.

At the infrastructure level, sharing economy platforms are centralised and concentrate massive amounts of user data, often making surveillance their business model. At the governance level, communities have no say in the decision-making, since only the platform owner decides how the platform evolves. Finally, the sharing economy markets are owned by just a few major industry players, which appropriate the value created by the communities, without redistributing the profits with their users.

Samer Hassan, Faculty Associate in the Berkman Klein Center for Internet and Society at Harvard University, and Associate Professor at the Universidad Complutense de Madrid (Spain), is the principal investigator of the P2P Models project. “The P2P Models project aims to create a new generation of sharing economy platforms powered by decentralisation”, says the Professor, who has studied communities and decentralised systems for a decade.

## Commons-based peer production communities

Commons-based peer production (CBPP) communities could contribute to a powerful perspective to sharing

economy as it is understood today. CBPP is an emerging innovative model of production characterised by peer to peer collaboration for the creation of shared resources, which are freely accessible and reusable by anyone.

Different experiences of CBPP communities such as Wikipedia, free/open source software, or Couchsurfing, provide radically differing values and practices when compared with those in markets. CBPP communities show us how cooperation can triumph over the competition.

The experience of these communities offers an interesting perspective to tackle sharing economies’ challenges, as they propose common ownership over appropriation of value, and participatory production and governance models over corporate control.

Blockchain technology could bootstrap the transformation of the sharing economy, providing a decentralised technology to challenge current centralised monopolies, and building decentralised governance and value distribution tools we could not have imagined before.

## Decentralised technology to support CBPP communities

CBPP communities have three main characteristics which are: decentralisation, as authority resides in individual agents rather than a central organiser; the use of open-access shared

resources; and the prevalence of non-monetary motivations.

These three characteristics of CBPP are aligned with blockchain features. First, both CBPP and blockchain strongly rely on decentralised processes, thus the possibility of using blockchain infrastructure to support CBPP processes arises. Secondly, the shared resources in CBPP are aligned with the shared ledger present in blockchain’s infrastructure, where data and rules are transparent, open and collectively owned. Finally, as previously mentioned, CBPP relies on multi-dimensional forms of value and motivations and blockchain enables the emergence of multiple types of non-monetary interactions and rewards (sharing, voting, reputation, etc).

Such an alignment leads us to think that blockchain could facilitate coordination, scaling up, or sharing of different forms of value amongst communities in an interoperable way. David Rozas, a social researcher (PhD in Sociology) and computer scientist (MSc and BSc in Computer Science) at P2P Models, thinks that “Decentralised technologies are a thrilling arena to experiment with cooperative dynamics. They could provide means to increase transparency, facilitate coordination or make visible forms of value which have been traditionally ignored”.

Blockchain can also enable new value distribution models, including the





Image: © Tony Webster. Unsplash

distribution of a token that can be exchanged for real goods and services. This may improve the economic sustainability of both contributors and communities.

### Tokenization as a multi-purpose tool

The rise of blockchain-based cryptocurrencies is a product of “tokenization”, i.e. blockchain’s unparalleled facility for the creation, transfer and management of tokens in a distributed manner. This process of tokenization facilitates the distribution of value and incentives. Furthermore, such tokens may be used as more than holders of monetary value: they may represent equity, decision-making power, property ownership, or access permissions.

Thus, blockchain capabilities, such as tokenization, enable the encoding of governance rules into code deployed in the blockchain. This enables communities to readdress latent power relations. This implies an exercise within the community to specify its internal processes and tasks to be

carried out, including traditionally invisible tasks. That is, caring tasks such as emotional labour, conflict management, maintenance, or events organisation, may be visibilised and acknowledged by the community – along with those undertaking such tasks.

Silvia Díaz Molina, P2P Models anthropologist specialised in gender studies, underlines that “one of the blockchain’s most interesting characteristics when talking about communities and power balance comes when automating processes and encoding rules in the software. Since communities must then discuss every process and every task, this makes all the power dynamics explicit. If the whole community is involved in the creation of the tool, even the most forgotten tasks, like the caring tasks, will come to the surface”.

We strongly believe that the combination of CBPP and blockchain provides an exciting field for exploration. However, “we should be careful with the blockchain hype and be critical with

the dominant techno-determinist discourses surrounding the crypto-world” adds Rozas.



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# How blockchain and smart contracts are impacting business functions

Jacqueline Watts, Senior Associate Solicitor at A City Law Firm, explains how blockchain and smart contracts are new technologies which have impacted the many business functions of different companies across various industries

Technology has substantially impacted the many business functions of different companies across various industries, whether it be payroll systems or company intranets. The areas which have remained fairly stagnant, however, are the processes of bookkeeping and signing contracts. Blockchain and smart contracts are new technologies which have been introduced to change the ways businesses fulfil these functions, bringing them up to speed with modern technology.

As these new technologies break through, many have raised questions about the security of using blockchain and smart contracts within a business, as well as their compliance with data protection regulations. In this article, I respond to the top questions about these technologies, as well as providing my insights into the legal implications of using them.

## What is blockchain?

In its purest form, blockchain is a shareable electronic ledger which can be continually updated. Its most defining features include being able to transport data on a peer-to-peer basis without the ability to edit or remove previous entries, meaning an accurate log of activities can be retained. The highly sophisticated encryption of the blockchain means that it is an exceptionally secure technology. Given this security and the nature of the ledger, there is no need for entries to be validated by any authority, meaning it is often said that blockchain is 'decentralised'. It is the blockchain technology which has enabled cryptocurrencies like Bitcoin to exist. Blockchain is by its nature public and all parties can see what has been recorded on the ledger.

## Why is it called a blockchain?

The reason behind its name is that the shared database contains 'blocks' which are records of transactions.

These records are chained together through a common set of rules.

## What is a smart contract?

A smart contract is an idea of using the blockchain technology to record and formalise a transaction. Whilst still in its infancy, there are confusingly many different uses of the term 'smart contract'. However, it is the idea that the 'rules' of the arrangement and an accurate log of the transaction will be recorded within the code.

## Are smart contracts legally binding?

English law does not prescribe a form of a contract. Just as oral contracts can be formed, there is no reason why a contract by code couldn't be formed. As with all new technology, one has to look at the fundamental legal principles. Importantly, parties signing the contract need to understand what is it that they are agreeing to and what the code will do.

The fact that the contract is in a form of a code does not negate the principles of forming a contract; offer, acceptance, consideration and certainty. What does change, however, is predicting when each principle of forming the contract is met. It remains to be seen how the court will decipher these principles when the contract is in the form of a code.

## What could a smart contract do?

There are numerous possible uses for smart contracts and their uses are almost endless. The security features and the ability to record all steps in a transaction lends itself perfectly to scenarios where ownership is being transferred. For example, when selling a property, the property ownership could be transferred automatically upon receipt of the cleared funds. Smart contracts can be used to show who has created a product,

so there can be little dispute over its intellectual property ownership.

Smart contracts can even be used for paying out insurance policy claims. For instance, there can be a smart contract for a flood insurance policy, linked to data from the Met Office. When the data feed shows the threshold is met, the policy would automatically pay out claims.

### **What are the advantages of using smart contracts?**

It can be cost-effective. If the code works, it can be replicated for similar transactions.

Secondly, the inbuilt security features mean that it is very secure. This is ideal for very large financial transactions where considerable sums may be changing hands.

Thirdly, it is very transparent. All parties will see everything that has happened on a particular transaction. This means, for example, you can clearly track ownership rights such as for intellectual property.

### **Limitations of smart contracts**

Contracts often have a lot of subjective elements. For example, contracts often use the words 'reasonable' or 'best endeavours' or 'good faith.' This leaves room for flexibility. Sometimes this flexibility is intentional because parties want the contracts to be more relational rather than transactional. The contract is designed to evolve as the parties' relationship evolves. In that case, smart contracts may not be the best option.

Moreover, smart contracts may not (at least for the foreseeable future) be able to deal with the complexity and the length of some transactions.

### **A lawyer is still needed!**

Usually, it is much emphasised that a smart contract is a contract that self-executes through software code, therefore, there is no need for lawyers anymore. While it is true that a smart contract self-executes, the conclusion that it makes lawyers redundant is inaccurate.

Despite the wonders of smart contracts, most transactions will still require a lawyer. The reason for this is that the lawyer will still need to assist in negotiating the

legal and commercial terms of a contract, advise the client on the law and then take the negotiated deal and convert it into legally binding principles. The only real change is that there may be an additional step. It is possible that the lawyers may have to sit with programmers to dictate what the code has to do. It does not mean that a lawyer now suddenly needs to learn how to code but it may just extend the function of a lawyer.

Further, there is also a lot of discussion over the simplicity of smart contracts and the view that simple language and process will be used to remove what many see as over complicated legal drafted. However, legal language has evolved through centuries of legal cases - each deciding on a very specific interpretation of common and legal language. To dispense with such is likely to only foster more disputes rather than aid in their removal. We would, therefore, urge the careful use of smart contracts where there are significant risks of disputes and ensuring that all legal expressions are used accurately.

However, this technology may eventually remove the need for third parties such as notaries to validate the authenticity of a document.

Finally, the technology may replace certain functions of a lawyer or change what we believe to be the current functions of a lawyer. This does not mean that lawyers will be replaced outright but that the legal landscape may change dramatically.

### **Conclusion**

Overall, the use of smart contracts is an interesting concept and it is easy to see how it can revolutionise the way business is conducted. However, the technology is not yet as developed as needed for smart contracts to become a part of everyday work-life, but there is certainly scope for it to reach that stage. ■

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# Kazakhstan: On the challenging road to gender equality

Gulshara Abdykalikova, State Secretary of the Republic of Kazakhstan charts the country's challenging journey on the road to gender equality

Following the sad passing of former United Nations Secretary-General Kofi Annan, we should remember his wise counsel, 'gender equality is more than a goal in itself. It is a precondition for meeting the challenge of reducing poverty, promoting sustainable development and building good governance.'

Kazakhstan is working hard to address these challenges. As an outward facing, aspirational nation at the heart of Central Asia, our government is committed to improving the lives of women at every level of society.

The opportunities open to women and girls, especially in their early years, determines not only their individual futures but also that of wider society. It is with this belief in mind that we continue to build upon advances made over recent decades so that Kazakh woman and girls can reach their full potential.

President Nazarbayev has set the ambitious goal for Kazakhstan to enter the ranks of the top 30 most developed countries by 2050. This goal is unachievable without drawing on the skills, knowledge and expertise of all our citizens, women and men alike.

Of course, words and policies are not enough, investment is vital. The government recently allocated \$56 million to support female entrepreneurship. In 2017, female-led SMEs created one-third of all jobs and with this recent investment, this figure is set to grow substantially.

The private sector too must continue to play a leading role in reducing barriers to access and support its female workforce. In many sectors such as finance, insurance and pharmaceuticals, women leaders are commonplace, but other industries such as extractives, transport and logistics must do more to support their female employees, especially in more rural communities.

For its part, the government will continue to support and encourage equality in the workplace and hold private companies to account by calling on them to sign up to the Women's Empowerment Principles.

Despite successes, we recognise that further progress is needed. More robust safeguards must be put in place to protect those who are most vulnerable, especially in rural areas.

In partnership with local and international NGOs and



*Gulshara Abdykalikova, State Secretary of the Republic of Kazakhstan*

Kazakh enforcement agencies, we are conducting an uncompromising fight against domestic violence. Our government has strengthened legal safeguards to help protect victims of domestic violence and to effectively prosecute the perpetrators of these heinous crimes. Thanks in part to these efforts, the level of household crime has decreased 40% since 2010.

The Concept of Family and Gender Policy of Kazakhstan until 2030 is also helping to dispel myths and challenge historic misconceptions, so that current and future generations of Kazakh citizens will not uphold gender biases and will challenge such preconceptions wherever they are found.

Sadly, instances of discrimination are still present in Kazakhstan, as seen by some derogatory comments on social media aimed at women's rights activists. The Family and Gender Policy, which builds on international best practice, is focused on eliminating such discrimination and will ensure that discussions around the critical topics of sexual health, reproduction and gender bias are no longer considered taboo.

While Kazakhstan has made notable progress over the last three decades, many countries in the region have not been so fortunate. For many girls, post-primary education remains a luxury, not a right, and in wide areas of Afghanistan, women regularly face violent persecution in their pursuit of careers.

Kazakhstan has provided significant support to Afghanistan, including a \$50 million scholarship

programme to educate 1,000 Afghan students. Discussions on how Afghan women can be further supported by the international community will also be a central theme at the upcoming 'Conference for the Empowerment of Women in Afghanistan' which is being held in Astana in early September.

Elsewhere, human trafficking across the Central Asian region remains a persistent concern. A national plan to combat trafficking, first introduced in 2009, has helped to deliver a significant increase in prosecutions. The government is working closely with domestic civil society organisations to

coordinate assistance for trafficked victims.

Education remains crucial to eradicating this issue. All Kazakh students at high school and college level now receive training on trafficking awareness so that they can identify and alert authorities should they encounter potential instances of trafficking.

Kazakhstan's goals are ambitious, especially considering the complex challenges facing the wider region. However, our government is firm in its commitment to protecting the rights of women and girls and eradicating gender discrimination at every level of society.

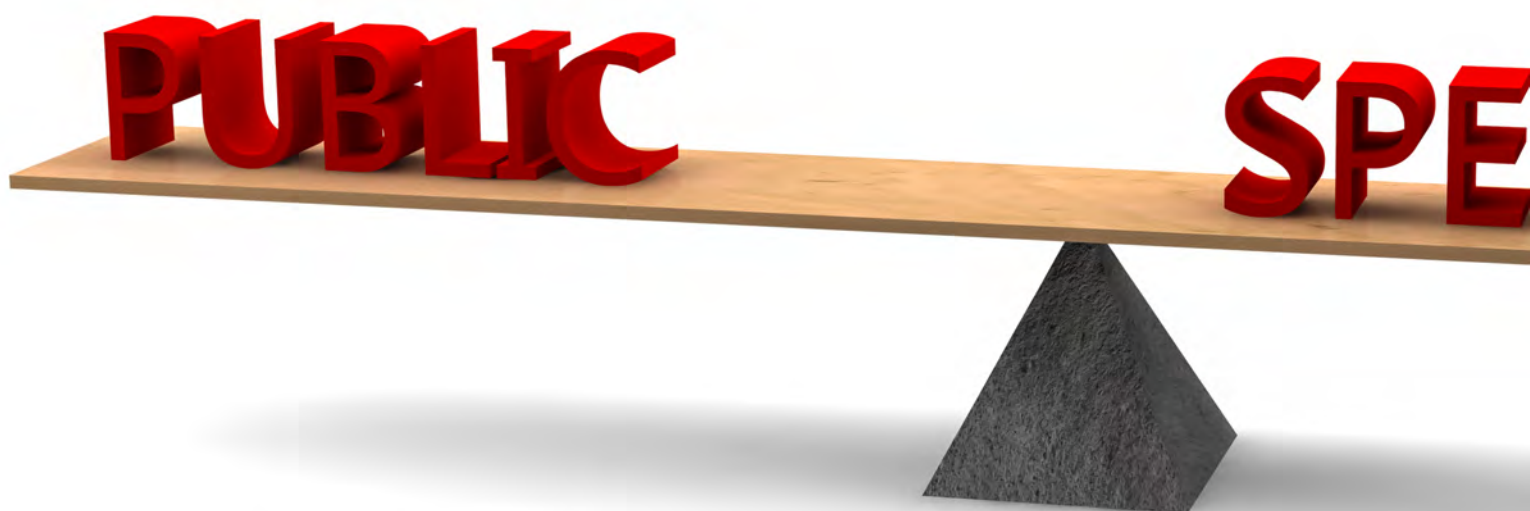
Educating Kazakhstan's citizens will play an important role in regard, so too will concrete policies which have been put in place to protect women in the workplace, home and in the communities. While basic protections are important, we must go further, reducing barriers to entry so that women are empowered to compete with men for all jobs at every level.

If Kazakhstan is truly committed to entering the ranks of the top 30 developed countries by 2050, meaningful equality will be crucial to our success. ■

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# Public spending pressures: Getting more value for the public purse

Paul Bentley, Commercial Agreement Manager at the Crown Commercial Service (CCS) details their Spend Analysis and Recovery Services, or SARS II, Framework tool and how this is helping those who spend money to get more value for the public purse

January is a month when thoughts may turn to stretching our household budgets. Those with the duty of spending money on behalf of the public face such pressures throughout the year and so are always looking for new and innovative ways of getting more value for the public purse.

Crown Commercial Service's (CCS) Spend Analysis and Recovery Services, or SARS II, Framework can do precisely that and at no extra cost to the customer. The "no win – no fee" principle that underpins the offer makes it a valuable weapon in the money-saving armoury. So how does it work?

First, we must accept that honest mistakes happen when handling large transactions. Such mistakes occur in both the public and private sectors but, until recently, the private sector has been more proactive in recovering the overspend.

Whether it be duplicate payments, overpayments, incorrect rates, missed discounts, incorrect VAT or contractual oversights, even the smallest of errors can lead to big figures when dealing with public sector budgets.

That's why CCS is encouraging government departments and the wider public sector to look carefully at SARS II – part of the suite of financial service frameworks available to central government and the wider public sector through CCS.

Under SARS II, all the potential customer need do is provide the data, readily available in any "accounts payable" or "enterprise resource planning system" then sit back while it is scrutinised by experts. They will identify any errors and report these for your authorisation to recover from suppliers in a professional and courteous manner, ensuring your relationships are maintained.





## GOVERNMENT

they have offered on the framework is acceptable and they have the needed expertise, then the award can be made.

Alternatively, if a customer feels that their opportunity is significant or offers a larger than usual scope, they may attempt additional savings via a further competition. CCS can provide guidance on both options.

It is the role of CCS to help organisations across the entire public sector save time and money on buying their everyday goods and services. Customers who have used our agreements have achieved commercial benefits worth over £600 million (compared to current market comparators) via some 1,260 procurements.

We see our role as helping our colleagues across the public and the third sector serve taxpayers even better than they already do, but this is not just about due diligence and prudent commercial management. We want to help change the way the public sector thinks about the way it works – whether it be adding social value to projects or spending public money more effectively.

We're now working hard to educate and encourage our public sector colleagues to look afresh at the SARS model and discover what the private sector has known for some time – that this is not about blame, it's about getting value for money.

Clearly more and more departments and organisations are keen to identify ways of generating more income, and SARS II may have a role to play in stretching the budgets of many public bodies. It's a tool which requires very little time and resources from the customer, but the returns can be worth hundreds of thousands of pounds. ■

*For further information on SARS II please visit the [agreement page](#) on the CCS website.*

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Only when the cash is back in your bank account will the SARS II suppliers invoice for their fees – which amount to a percentage share of the recovery. If no recovery is identified, there's no fee at all and, if a recovery is identified but the customer chooses not to take it any further, there's also no fee to pay.

Spend recovery has been so successful in the private sector that many larger organisations now have their own dedicated departments carrying out these deep dive audits annually.

So, how might a public sector organisation go about this? CCS customers have two routes to market: either a direct award or a further competition.

The direct award route enables customers to quickly access the market. Select a supplier who is able to supply the service requirement and, if the price

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# Public sector overcharges and overpayments

Twice2much investigate how much of the public sector overcharges and overpayments, worth £220 million, could be yours

Every year, any organisation is susceptible to being either incorrectly charged for the goods and services that they procure or pay more than once for purchases they have made.

Overpayments happen due to a variety of reasons, ranging from accidental misposting of invoices (to the wrong supplier in the first instance) to invoices being raised by supplier branches and then their own Head office finance teams.

Regardless of how overpayments happen, spend recovery reviews provided by external specialists are the most commonly used route for identification and recovery. These services are generally provided by third parties on a 'share of recoveries' basis and therefore there are no upfront costs to the organisation and all the risks lie with the provider of the service.

Whilst no one can predict the likely recoveries from such a review, the fact that suppliers of these services are still in business is a testament to both their abilities to identify and recover monies and that overpayments are still being made by organisations regardless of improvements in system and controls.

Hundreds of millions is recovered every year within the private sector.

The public sector is not exempt from this but has been slower to respond,

mainly due to perceived issues around tender limits etc....Crown Commercial Service (CCS) – the UK's largest public procurement body, responsible for shaping and delivering government procurement policy – estimates that £220 million in overcharges and incorrect payments could be recovered over the next four years. To facilitate the identification and recovery of these valuable funds, CCS has created the Spend Analysis & Recovery Services framework to enable public sector organisations to procure these services more easily.

## How it works

Under Spend Analysis and Recovery Services (SARSII) – Framework Agreement RM3820, public sector organisations can save significant time, resource and cost because virtually all the procurement issues have been addressed by the framework eliminating the need to conduct their own full procurement exercise.

The suppliers on the framework have already been carefully evaluated during the tender process against set criteria:

- Quality;
- Technical Merit including capacity to supply, performance, reporting, references, Insurances etc;
- Security Considerations;
- Environmental/Social considerations;
- Financial Assessments;
- Price.

The revised framework (SARSII) allows public sector organisations to procure a more specific range of services by splitting the Framework into various lots. It also enables customers to select a supplier via either direct award or a further competition tender to those suppliers on the framework.

## How do you choose your supplier?

This is the most difficult element to consider.

You have a choice of up to Ten Suppliers on any individual lot on the Framework, all quoting different costs (as fees are based on a 'share' of recoveries only, across various recovery ranges) with neither the Customer or Supplier able to predict likely recoveries and therefore costs.

Experience to date suggests that organisations have been looking at 'cost' rather than 'benefit'. There is clearly a need for better understanding of the nature of these reviews but these are minor challenges compared with the potential benefit. CCS is there to assist and guide organisations along the way...

**twice2much**

**Andrew Cushion**  
Managing Director  
Twice2much Limited  
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How much could our review be worth to you and your services?

Simple as...

## 1 Contract Award

- Identify scope of review
- Understanding cost/benefit factors
- Award contract

## 2 Data Extraction & Analytics

- Identify and obtain data required for review
- Opportunities for recoveries identified using advanced analytics
- Results verified on behalf of the Client

## 3 Money Recovered

- Suppliers contacted for confirmation of overpayments
- Monies returned direct to Client
- Suite of reports provided to Client



**£10m**  
recovered  
from HMRC



**£10m**  
recovered  
from Contract  
Compliance  
Reviews



**£20m**  
recovered  
from Statement  
Credits



**£100m**  
recovered in  
Overpayments



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SPEND ANALYSIS AND RECOVERY SERVICES II (SARS II) –  
FRAMEWORK AGREEMENT RM3820

Crown  
Commercial  
Service  
Supplier

# Challenges faced by the public sector: Shared ambitions lead to shared success

Paul Bradbury, Group Business Development Director, Civica explains how shared ambitions lead to shared success when it comes to the challenges faced by the public sector

The challenges faced by the public sector have intensified over the last few years. The demands on public services are evolving rapidly, as the way people interact with the public sector changes, together with their expectations. Also, continuously shrinking budgets continue to cause strain, which means “working smarter” and transforming the way services are delivered is crucial to success in this unstable environment.

As part of this ambition to work smarter, a number of local government organisations have come together to create [The Local Digital Declaration](#). This declaration is a commitment to developing common standards for the common elements of local services; working together to share knowledge, and ultimately to pave the way for the next era in public service delivery through building services more quickly, flexibly and effectively, together. But crucially, The Local Digital Declaration is aiming to put technology at the forefront of re-shaping public service delivery. And this is vital as people want the same level of instant service from the public sector as they do from their bank, favourite retailer or travel company.

## Working together is better than working alone

Some organisations are already making good headway on the journey to smarter working by consolidating and sharing services to respond to local challenges. But there is no doubt that the public sector needs to move to a more flexible way of working. Key to this is building on technology and innovation to gain a single view of the citizen and their interactions to deliver citizen engagement and business administration more simply, efficiently, cheaply and in keeping with other experiences people now have.

In the past, many public sector departments and organisations have worked in siloes, but to design services that best meet the needs of citizens, these bodies must work together in partnership to drive innovation. Gaining trust and developing a strong leadership team is vital here. Working in partnership, rather than autonomously is a big change and must be treated with care.

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**“From an IT point of view, it’s crucial to integrate technology so that every team/organisation can access the same systems to improve workflows, enhance service delivery and achieve the most efficient, seamless and convenient experience for citizens.”**

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The key is building a strategy, together, to deliver services designed around people. This comes from automating processes, connecting data and supporting increased and better local engagement alongside operational efficiencies. However, public services deliver a very broad array of services underpinned by complex and changing legislation and regulation, so there needs to be a balanced approach to change.

And with the GDPR coming into force earlier in 2018, designing safe ways of sharing information, demonstrating digital leadership and embedding an open culture that values, incentivises and expects digital ways of working from every member of the workforce will be essential to delivering on these commitments.

From an IT point of view, it’s crucial to integrate technology so that every team/organisation can access the same systems to improve workflows, enhance service delivery and achieve the most efficient, seamless and convenient experience for citizens. These solutions





must be flexible, fast and efficiency-focused to achieve common standards across local services. This will enable collaboration, integration and uniformity of data structures; which will, in turn, help the initiative achieves its aims.

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**“The key is building a strategy, together, to deliver services designed around people. This comes from automating processes, connecting data and supporting increased and better local engagement alongside operational efficiencies.”**

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However, these local organisations cannot ignore the issue of trust. While people freely transfer money by mobile banking apps or share locations on social networks, only 57% of citizens we spoke to claimed to trust the government to handle their data, this is despite half of the respondents believing that data sharing would lead to better services. The imperative here is to educate both citizens and local government employees on the benefits of sharing data and on data safeguarding.

Public sector organisations across the country have a responsibility to explore the opportunities enabled by the Local Digital Declaration to deliver efficient, accessible and always-on services to improve the lives of all citizens across the country. That’s the only way that these shared ambitions can lead to shared success. ■

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# The decline of the traditional office: Are smarter ways of working the replacement?

With the traditional office lease in demise, Alison White of PLACEmaking looks at what is emerging as a replacement in terms of smarter working, including the impact on people and how support services need to be repurposed

Commercial letting agents are reporting the rapid demise of the conventional office lease and the increase in demand for more flexible terms and altogether new workspace solutions. With the trend growing for businesses to temporarily contract resources to cope with changing volumes of workload plus the outsourcing of specialist content, the days of predictable office space requirements based on a static headcount is over. As a result, in place of long-term commitment to ever-increasing rent rises and skyrocketing service charges, new solutions are being sought that allow organisations to be nimbler, flexing in response to the consequences of political and economic uncertainty but also increased acceptance of newer, smarter ways of working.

## Working remotely and workspaces

The typical working week has been changing for some time. In place of Monday to Friday, Monday to Thursday has become increasingly common with “work-where-you-like” on a Friday and ad-hoc use of home and camping in high street cafes becoming the new norm, enabled by remote access to information and communications. As this pattern has matured, working remotely has expanded beyond just Fridays, with organisations becoming increasingly aware that the expense of providing underutilised space and services is unsustainable. Whilst in the

past they would have assumed that if they can't see their staff how would they know they were actually working; enlightened managers have recognised that productivity can't be measured simply by presenteeism.

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**“For well-established businesses, rethinking their workplace solutions and implementing wider participation in smart working, encouraging remote working and, in turn, reducing their owned office portfolio requires balancing the contemporary demands of targeted recruits along with the expectations of an existing workforce.”**

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Many organisations are accepting that in place of imposing the misery of pointless commuting every day, they need to actively support their staff have a greater choice of where they work for at least part of their week. An appetite for new more flexible property solutions has emerged with businesses adopting a smaller footprint of their own core branded space with a distributed network of time charged serviced offices, local to where their resources live.

Whilst employer focused cost control pressures are inevitably fuelling the demand for more flexible property solutions, it is the significant change in our attitude to what ‘going to work’ means and workforce demands for a better work-life balance that underpins the momentum for a rethink in

where and in what sort of environments we want to work. Whilst in some places there is an on-going battle still raging about what's the best office solution either open-plan or cellular solutions, the reality is physically going to the ‘office’ is rapidly becoming less of a daily necessity and more just one of many options.

Such options have expanded beyond the simple alternatives to the office, i.e. just home or the local coffee shop to now include independently owned and operated workplace ‘clubs’. Unlike the ‘serviced office’ providers that have been around for some time, new providers are delivering a fresher new offer. Paid for on monthly subscription, these workspaces offer characterful places in contrast to the ‘vanilla’ serviced offices of the past. Where once these new ‘funky solutions’ were regarded as relevant only to the start-up tech and creative industries and even for them a passing fad, these new clubs are attracting a wider range of users because of their warm, friendly, contemporary styled modern mix of eclectic interiors with exceptional technology, connectivity and service infrastructure.

The trend for using these solutions has expanded into more of the mainstream and enterprises of all sizes and shapes now regard them as a legitimate part of their broader accommodation solution. Whilst some may



regard 'cute' co-working clubs filled with the ubiquitous whiff of fresh coffee and inevitable table football machine as a bit of a cliché relevant to the 'snowflake' generation, many of the subscription users of such places are in fact full-time mainstream corporate businesses staff or their specialist contractors.

## What's the attraction and what's the risk?

It's not difficult to appreciate the tangible financial benefits of reducing the traditionally leased office to a minimum supplemented by these flexible office clubs. In terms of attraction to the individual though, it's more complex. In part, the attraction is avoiding unnecessary commuting and avoiding the frequently reported loneliness and isolation when working from home but it's more than that, it's about being part of something that the corporate office rarely if ever achieves. It's about stimulation, inspiration and motivation and most importantly, unlike when

confined to a single employer-owned office, if you don't feel you're getting what you want from one workplace, you can simply end your subscription and move on the next one. Institutional office politics don't apply in these places either which means, however, senior or junior your grade, everyone has the same rights and behavioural obligations. Employees of one organisation co-work quite happily alongside others, from the large and long-established organisations to minnow brand new enterprises, all without the physical boundaries of walls or management constraints.

## Why people prefer these informal workspaces

Listen carefully to why people prefer these informal workspaces to their employer's offices, and they include:

- Ease of access, avoiding commuting;
- Stimulating environment, like-minded co-workers;

- Enterprising culture;
- Informal atmosphere, dress code, attitude;
- Contemporary design;
- Modern food, art, music offer;
- Lack of corporate stamp;
- Emphasis on a characterful environment;
- Technologies that work;
- No hierarchy and office politics;
- They're just happier when they're there.

Importantly, it's the function of these place to facilitate co-working: to encourage interaction between individuals and across organisations, which, in turn, supports a greater collaboration and shared enterprise



that results in innovative thinking which, in turn, benefits everyone if they are prepared to take advantage of emerging opportunities. New behaviours are emerging.

There is a risk. It's relatively easy to conceive and deliver new solutions when your business is just starting out and the canvass is blank, but demonstrating a willingness and responsiveness to new challenges and navigating through such changes in more well-established organisations does have its challenges. Limping on with out-dated workplace solutions might have appeared to be a savvy economic saving but now the design and functionality of the workspace offer are regarded as a key expression of an organisations intention to stay relevant and competitive, rendering such savings as short-sighted.

## Behavioural change

Whilst turning the 'big ship' that is the property market to respond to these emerging demands for different workspace solutions to what the market has spent decades delivering, the importance of the physical PLACE is not diminishing, but it is different as PLACEmaking explored in '[Do we really need to build any more office buildings](#)'.

For well-established businesses, rethinking their workplace solutions and implementing wider participation in smart working, encouraging remote working and, in turn, reducing their owned office portfolio requires balancing the contemporary demands of targeted recruits along with the expectations of an existing workforce. Whilst focusing on recruitment messaging is important, hanging on to

those high-value recruits beyond the initial honeymoon period and retaining key resources within the existing workforce is essential. This is best achieved by creating opportunities to mesh new initiatives and approaches with the best of existing behaviours, leaving behind those no longer relevant. Unsympathetically addressed, attempts to adapt long-established behaviours can be destabilising and a distraction for the business, often resulting in unnecessary negativity towards the engagement process itself, if not conflict towards the vision and business objectives driving new workplace initiatives.

Many aspects of change appear complex and indeed they are. Some are so rooted in tradition and so established in the norms of day-to-day activities that even the notion of challenging their continued existence can appear somewhat illogical. Yet if smart ways of working are to be successfully adopted, then some embedded behaviours must be challenged.

Two examples spring to mind. One of which must be the routine, weekly one-hour meeting. With instant access to business-related performance data and immediate, reliable low-cost video communications connecting people, however, remote their location, the continued pattern of routinely bringing people together, often in uninspiring meeting rooms, sparsely furnished, poorly ventilated and lacking any modern technologies to assist insist paperless information sharing is a mystery and a misery to many.

## Do we need meetings?

So why do we keep arranging and attending them? Recent media cover-

age set out [Elon Musk's views on pointless meeting](#) highlighted how quickly behaviours can become entrenched even when the purpose of them is sometimes lost. Compare the landscape of a typical corporate office full of static meeting rooms with what's on offer in office 'clubs' where the emphasis is on connectivity, spontaneous discussion and speedy decision making. There the emphasis is on speed and connectivity: modern, informal, interactive collaboration spaces are all comms and technology-enabled, encouraging spontaneous interaction, problem-solving and speedy decision making.

## Communication – the prevalence of emails

The second example is how people communicate and specifically, the behaviours associated with email, dependency on it as a tool has become entrenched in many organisations. Most users have a love/hate relationship with email but for long-established organisations, there's no obvious absolute replacement. Whilst we now carry around our cable-free computing devices and the very purpose of smart working is to support new ways of working that reduces administrative tasks and increase creative innovation, some behaviours associated with emails assume receivers have nothing better to do than instantly read and reply to emails.

The use of email can be so invasive that individuals dread going on holiday not because they'd rather be working than enjoying some carefree time with friends and family – but because they know that their first few days back will be spent sifting through hundreds of pointless emails jammed into their

inbox searching for the odd one that is actually important and they must 'file'.

By rejecting inflexible property leases on uninspiring office buildings and interiors and pursuing alternative solutions, pioneering businesses including those that are start-ups or more established are not just choosing a different workplace solutions, they are signalling they intend to operate in a completely new way and demonstrating how business is transacted with and between them will be altogether different going forward: reflecting modern demands to embrace new codes of behaviour and a better balance of personal and professional expectations.

## Aligning support services with smart ways of working

Adapting embedded behaviours and transforming traditional workplace solutions in line with smart working is made difficult, if not impossible where established HR policies and support service practices are not fully aligned. In established organisations, these services have evolved to efficiently and effectively service and support the status quo and so it's inevitable they can be at odds with the changes a leadership team must lead if their organisations are to adopt smart working and stay relevant and attractive to the best talent. Some examples of where these support services need to change include:

### Human resources (HR)

One people focused change is the meaning of the words 'manage' and 'manager'. Both need new definitions when presenteeism and eye-to-eye contact no longer applies. Smarter ways of working demands and enables

the development of new innovation skills in place of the past emphasis on multiple layers of management.

A greater emphasis is now on data analysis, problem-solving, individual responsibility and judgment, increased focus on sharing experience and knowledge, relationship building, cross organisation collaboration and active communication.

As teams and individuals work remotely, in place of the command and control structures of the past, a greater emphasis is needed on engagement and developing a culture of commitment and enterprise to achieve objectives through consensual team charters and the non-hierarchical sharing of challenges, targets and rewards.

### Facilities management (FM)

A key support service that has too often measured by cost rather than the quality of service delivery. Smarter ways of working will make more and different demands on FM broadening the focus beyond fixed asset, cost-driven building services and maintenance to a greater and more active facilitation of customer service delivery. With reduced scale and scope of services focused on traditional property assets, higher valued 'people' focused services will need to emerge, offering greater levels of virtual support for remote working in places operated by others and the servicing of increased value and performing assets, but in a reduced scale of facilities and assets and in a wider range of remote physical environments. Fundamentally the specification of service level agreements (SLA's) and pricing mechanisms for this enhanced

service can no longer be based on a square footage charge but increasingly on quality of outputs and results of its customers and the service they, in turn, deliver to the end users.

### ICT

Another key support service, all too often constrained in the delivery of narrow, cost-driven and multiple threshold based delivery solutions that somehow consistently miss user expectations. Often encapsulated in technical jargon that as a result, reduces the value of the vital tools and service required and undervalues the supply and maintenance of core services which overall results in a disconnection from the service and the human resources that are intended to exploit the technical solutions on offer.



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# The declining high street: A final nail in the coffin of local government services?

Nigel Wilcock, Executive Director of the Institute of Economic Development (IED), shares his opinions on the declining high street and ponders if this is a final nail in the coffin of local government services

**T**he general public have not yet caught up with the fact that no-one knows how local government will be funded beyond 2020 – or that the seemingly unrelated crisis on the high street, with large chains collapsing all around us, is increasingly a contributor to this issue.

The basic problem is that councils were supposed to be self-financed by 2020 through the retention of business rates and with a formula to redistribute from those areas with a large amount of related revenue to those with less.

The Local Government Finance Bill to enable this to happen was omitted from the most recent Queen's Speech after being dropped from the government's agenda due to the quickly-called 2017 General Election – and now there is no plan.

The Local Government Information Unit has noted that 80% of councils fear for their financial sustainability and there is concern that the cash-ravaged Northamptonshire County Council is the tip of the iceberg for local authorities.

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**“For millions of UK residents, it is unclear how adults and children’s social services will be run in the future, how local roads will be maintained and whether any libraries and leisure centres will remain open – not to mention how local government workers will be paid their pensions.”**

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The uncomfortable truth that needs to be heard is that every pound lost on business rates is now a pound lost to essential local government services. Retail is a huge contributor to business rates and critically important to the remaining sources of local government funding.



Every time there is another large-scale retail closure, such as the recent House of Fraser announcements in Edinburgh, Hull and Swindon, there is a growing clamour for rates to be reduced to shore up the distressed retail sector. Throw in the usual demands for free parking in council-owned car parks to support town centres and local government faces a perfect storm.

For millions of UK residents, it is unclear how adults and children's social services will be run in the future, how local roads will be maintained and whether any libraries and leisure centres will remain open – not to mention how local government workers will be paid their pensions.

The Local Government Finance Bill was supposed to deal with this uncertainty. Now we are looking at a worst-case scenario where the central government funding mechanism finishes in 2020 but without a plan to pick up the pieces.

Overall, there is a need for a greater spotlight on local government finance. The 'Future of Local Government Funding' may be on the agenda at a Local Government Strategy Forum in Cheshire in the Autumn of last year, but we need a public debate – a debate which would be better served if the information was clearer on exactly what services now need to be funded by local taxation.

There is a case to be made for linking this to the new UK Shared Prosperity Fund (UKSPF) – although the title may seem like 'schadenfreude' to some local authorities. The government is currently consulting on the creation of a system to replace the European programmes that fund local services and regeneration programmes which come to an end for the UK in 2020 (or presumably in 2019 if there is a 'no deal' Brexit). The redistributive mechanism for business rates seems to be closely related to the required allocation of funds to underperforming regions within UKSPF.

From the IED's perspective, it seems that if statutory activities are forced on local authorities there should either be some central funding – or that local authorities are given more freedom over the tax revenues they can generate. We urge a clear statement for local government funding post-2020 and suggest that the formula for redistributing business rates is pegged to the same distributive formula as the UKSPF.

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**“The uncomfortable truth that needs to be heard is that every pound lost on business rates is now a pound lost to essential local government services. Retail is a huge contributor to business rates and critically important to the remaining sources of local government funding.”**

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Finally, it should not go unnoticed that those local authorities which have been the most successful in their economic development approaches are now in the best position to survive. ■

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# Game-changing clean growth innovation in Swindon and Wiltshire

Paddy Bradley, Director of the Swindon and Wiltshire LEP gives an engaging glimpse into game-changing clean growth innovation taking place in Swindon and Wiltshire

The Swindon and Wiltshire Local Enterprise Partnership (SWLEP) champions local, sustainable growth and supports businesses at the heart of Swindon and Wiltshire's thriving economy.

The SWLEP has developed its strategy for Energy through which it is committing to concerted and sustained action to grow the local low carbon economy. Our priorities have been established through the analysis of rich sources of evidence based on publicly available data, business intelligence and stakeholder consultation. The priorities combine distinctive interventions that respond to the characteristics of the local economy, like hydrogen technology, with a recognition that the SWLEP should also support clean growth across all sectors, contributing to a diverse, productive and resilient local economy over the long term.

We also recognise that there are many opportunities to take advantage of new and cleaner energy technology that will be common to LEPs across the country. Shared efforts can deliver the infrastructure that secures the benefits across wider functional economic areas.

## Home of New Energy Vehicles and global leading hydrogen technology

Most industrialised nations are introducing vehicle emissions targets and automotive manufacturers around



*Energy Minister, Claire Perry MP attending a meeting of the Hydrogen Hub at Johnson Matthey*

the globe are responding to these demands in developing fit-for-purpose efficient New Energy Vehicles of all types and sizes. We are committed to supporting low carbon industries. Indeed, with a strong automotive industry heritage and a large vibrant network of innovative engineering, manufacturing and tech companies, Swindon and Wiltshire are the ideal locations for new energy vehicle research, design and manufacturing.

We are home to global automotive brand names such as BMW and Honda UK Manufacturing; high technology disruptor Dyson, which is developing battery technology and a new electric car and Johnson Matthey, a world leader in hydrogen fuel cell technology. They all attract a broad supply chain and a strong, experienced workforce.

Swindon is the only metropolis outside London with two Hydrogen Refuelling Stations; the UK's first public access station at Honda and a new station at Johnson Matthey's site, conveniently located for the M4 at junction 16.

Swindon and Wiltshire are ideally located within one hour of London. Heathrow and Gatwick Airports and Bristol and Southampton Ports are areas that boast a number of important sectors, which are complementary to the automotive industry for supply chain companies, including those who work in the areas of aerospace, agritech, digital and rail. Nearby universities and R&D institutions excel in new energy vehicle-related products and technology, such as the High Value Manufacturing Catapult; National Composites Centre and the Universities of Bath, Oxford Brookes and Southampton.



## PROFILE

Over 50 organisations are working together in and around Swindon to further the New Energy Vehicle industry. The Hydrogen Hub aims to promote the commercial use of hydrogen applications (including in automobiles) with the first hub formed in Swindon in January 2016. The Hydrogen Hub is an organisation that works to set up communities of stakeholders who collaborate to encourage investment in hydrogen and fuel cell technology.

Clare Jackson of the Hydrogen Hub says: "What we're doing at the Hydrogen Hub is building infrastructure hubs around captive fleets serving the needs of the local community. That way we can start to build up a network of hydrogen hubs with infrastructure that will then allow those users that need the flexibility to be able to travel nationwide to know that they've got an infrastructure system of hydrogen around the UK."

Arval, which specialises in vehicle leasing and fleet management, is one business involved with the Hydrogen Hub. Paul Marchment, Arval's SME (small to medium-sized enterprises) Manager details his thoughts on the mind shift towards ultra-low emission vehicles. "Zero emissions are really important to Arval because we lease a lot of vehicles", he says. "There is a mind shift towards ultralow emission vehicles, so we became involved in this because this is cutting edge tech-

nology. "We're still a few years away from mass deployment but we need to understand how it works now so that we're ready for the future when it does take off in a big way", Paul adds.

### Attacking plastic waste

The UK uses 5 million tonnes of plastic each year. Only 3.3 million tonnes of that is identified in the waste stream and of that figure, only 1.05 million tonnes is collected for recycling and of that just 360,000 tonnes is processed in plastic recycling centres in the UK.

The other 700,000 tonnes goes abroad (mostly the Far East), with uncertain outcomes. A chance conversation with an ex-colleague changed engineer and consultant Adrian Griffiths' thinking about waste and set him on the path to founding a firm that now stands on the threshold of launching its revolutionary technology that will transform the way the world recycles plastic.

Supported by private investment, government grants and a loan facility from the SWLEP, Recycling Technologies has developed and patented a plastics recycling machine, the RT7000, that converts plastic waste back into an oil called Plaxx® from which new plastics can be made. The machine heats up the plastic in the absence of oxygen to break the waste plastic down into Plaxx®. This process allows the RT7000 to recycle plastics currently considered unrecyclable such as plastic film, lami-

nated food pouches and crisp packets and even black plastics. These unrecyclable plastics are currently exported, incinerated or buried. The RT7000 machines are relatively small scale, allowing them to be located within existing waste management facilities, reducing the financial and environmental costs of transporting residual plastic waste. Recycling Technologies expects to be able to build 200 RT7000s a year at its new assembly facility in Swindon. Starting with the installation of its first commercial RT7000 in Scotland in 2019, an initial 12 machines are going out to recycling centres across the UK and Northern Europe, where they will be monitored to identify further areas for improvement. Thereafter the company will enter its mass -production phase. Since the company was formed in 2011, its staff has grown from three to 51 and is set to rise to almost 600 over the next seven years.

Adrian Griffiths, CEO, Recycling Technologies, said: "We have a goal to triple Europe's current plastic recycling capability by 2027 through the provision of 10 million tonnes of urgently needed new waste plastic recycling capacity. Our manufacturing facility here in Stirling Court, Swindon will be capable of manufacturing 200 RT7000 machines a year to meet the growing demand for plastic recycling capacity in the UK, Europe and the rest of the world."



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# Why does leadership training matter?

David Willett, Corporate Director, at The Open University explains why leadership training matters

**E**mployers in the UK are currently in a difficult and unpredictable position. We do not yet know what the long-term impact of Brexit will be on our workforce; both in terms of managing our existing talent, and accessing the skills we will need in the future.

If the UK's departure from the EU has an enduring impact on access to overseas talent, the public sector could find itself in a difficult or even untenable position, particularly in sectors such as the NHS, where one in eight employees are 'not of British nationality'.<sup>1</sup> Other areas of the public sector may also be significantly impacted, so it is crucial that employers carefully consider potential obstacles, and the workforce they will need to develop to overcome them, to ensure that they are prepared for the future.

With many challenges on the horizon – the fourth industrial revolution and our post-Brexit economy included – it will fall to leaders to effectively communicate and manage the changes faced by their workforce. But with 73% of employers struggling to recruit for leadership roles in the past year<sup>2</sup>, what can public sector employers do to ensure they are able to effectively weather the storm?

## Leading from the front

A strong leader can make or break a team, but worryingly, a recent study found that two-thirds of the British workforce believed that they could do a better job than their boss.<sup>3</sup> Not only can this mindset have a significant impact on personnel issues, such as loyalty and retention, but also undoubtedly has an effect on a work-

force's output and productivity. And in high-pressure working environments, such as the public sector, this can be problematic.

Over five million people were employed by the public sector in 2018<sup>4</sup> and with such a vast and diverse workforce to oversee, navigating change becomes even more of a challenge – and strong, competent leaders and managers become paramount. They need to be able to see new initiatives and technology put into place, but also communicate change and reassure more junior staff when necessary.

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**“With many challenges on the horizon – the fourth industrial revolution and our post-Brexit economy included – it will fall to leaders to effectively communicate and manage the changes faced by their workforce. But with 73% of employers struggling to recruit for leadership roles in the past year, what can public sector employers do to ensure they are able to effectively weather the storm?”**

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The public sector is renowned for its opportunities for career progression, with many workers joining shortly after leaving education and transferring between roles, industry specialisms or departments until they retire. But progression is often based on longevity, as well as experience, so workers can often find themselves in a management or leadership position without much guidance on how to manage people or budgets. Thrown in the deep end, many do pick up the skills they need – but it is a steep learning curve, which can take time that may not be forthcoming as the UK experiences rapid change.

At the same time, there is also a shortage of leadership and management skills in the labour market, which means it is time-consuming and expensive to hire in new employees – and even then it takes time for them to acclimatise to the role. So instead, to ensure that the public sector is fully future-proofed, employers should consider the benefits of offering formal leadership training to existing staff to overcome the issues of inexperience, either in a role or in an organisation.

### Using training effectively

It is a common misconception that leadership training and professional development are the reserve of the youngest and most junior members of a team. In fact, employees of all levels can benefit from continuous

professional development that gives them the opportunity to build on existing skills and learn new skills appropriate to more senior roles as they move up the ranks.

Learning should be a lifelong endeavour, and for the most part public sector employers are excellent at investing in people, both on the job and through formal training. But with the introduction of the apprenticeship levy, to which the public sector is the biggest contributor, there are new opportunities to develop the workforce.

With tight budgets, it is essential that organisations secure good return on investment, and use the funding in their National Apprenticeship Service accounts to ensure they have the skills they need to manage future changes – at all levels.

So, with a shortage of leadership talent, the public sector needs to ensure it is prepared for the changes and challenges that lie ahead; able to manage change and personnel effectively, and anticipate and plan for future opportunities and changes.

And while organisations already invest in training their workforces, the apprenticeship levy is a golden opportunity to develop strong and loyal leaders, who can motivate the workforce, drive forward plans and address issues with confidence. ■

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# 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

**T**he 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.

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**“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.”**

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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.



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# Can labour-market inequalities be reduced by negotiating at the company level?

Pierre Courtioux, Research Director at the Economics Research Centre (EDHEC) probes if labour-market inequalities can be reduced by negotiating at the company level

France's labour relations model is paradoxical, insofar as it combines a very low level of trade union representation (union membership rates are around 8% for the whole of the economy) with a very high percentage of employees covered by industry-wide collective bargaining agreements (around 98%).

This "traditional" method of organising labour relations was actually set up at the end of the Second World War when the industry or sector (branche) was designated as the main level for negotiation.

In practice, this system let the state play a central role in restricting wage inequalities: the state fixed the minimum salary and pushed to "extend" collective bargaining agreements to companies that had not signed agreements in the industries concerned (while indirectly making wages for the industry concerned exceed the national minimum wage).

However, company-level negotiation is no longer the poor relative in labour relations in France. A number of reforms applied since the first decade of the century have tended to decentralise social dialogue. The idea underlying these reforms is that the French model tends to maintain a high level of inequality, by creating a duality in the labour market, split between "insiders" who are largely protected by centralised bargaining agreements and "outsiders" who have difficulty in securing lasting employment.

These reforms have come with a change in the rules relating to trade union representation, which have served to strengthen the link between the votes cast in personnel-representative elections held at the company level and the representation of these votes in the agreement negotiation and signing process.

At first sight, this decentralisation might appear a great

success, given that the number of agreements signed each year has doubled in the space of 10 years.<sup>(1)</sup> In practice, however, the picture is more nuanced, insofar as these agreements are largely formal and stem partly from the legal obligation to negotiate.

Here again, and this is one of the traditional characteristics of the French model, the state has acted as the driving force for this change, by introducing a legal requirement for companies to negotiate, and ideally to sign agreements, on a certain number of subjects (with failure to do so being punishable with financial penalties in certain cases).

Can decentralisation of negotiations at the company level really reduce labour market inequalities in these conditions? Recent research work<sup>(2)</sup> in this vein highlights three points.

**First of all, the sectors “best” at company-level negotiation remain “unequal”.**

Research shows that certain sectors display a real company-level negotiating dynamic in all areas (wages, working conditions, gender inequality, etc.). This is most apparent in certain industrial sectors (chemicals and pharmaceuticals, metalworking), and in banking, insurance, culture/entertainment and communication.

These sectors are notable for having highly-qualified workforces and very low proportions of fixed-term or part-time contracts. Wage inequalities are the highest in these sectors, though they are fuelled by the relatively high proportion of high salaries.

**Next, firms that concentrate on negotiating wages at the company level do not display lower wage inequalities.**

Examples of this include companies in the hotels/catering, retail, cleaning, security services and medical/social sectors. They primarily comprise of small companies employing generally low-qualified staff and for which the proportion of fixed-term or part-time contracts and the level of wage inequality remain around average.

**Lastly, the absence of wage agreements does not mean a lack of progress in terms of work-related negotiations at the company level.**

Certain firms appear to have responded positively to incitements to negotiate. These sectors, characterised by a large proportion of low-wage, low-qualified staff, have signed company agreements concerning working conditions, working hours, employment and union expression (voice).

However, wage negotiations have generally failed to come to fruition. Examples of this include the transport sector, the food and beverage industry, construction and commercial services. Wage inequalities in these companies have remained low, notably because the bulk of the staff concerned are low-qualified.

These results show that the content and result of company-level negotiations are heavily influenced by the qualification levels of the labour force and the size of the firms in the sector. As a result, these factors are liable to accentuate inequalities in terms of wages and working conditions on the French labour market as a whole if due attention is not paid to them. ■

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# Empathy and remaining firm are two sides of the same coin in management

As a manager, or even a colleague, finding the balance between showing empathy and remaining firm is tricky, but it's an important skill to learn and develop. James Larter from RoleplayUK explores why

**M**any of us appreciate that empathy is crucial to any working environment. It's an unwritten understanding that we are heard and valued, reinforcing an instinct to want to contribute to the best of our ability.

When discussing empathy, it's easy to think of it as too "touchy-feely" for work, but empathy goes beyond just creating a pleasant or caring atmosphere in the office. It's an essential skill that managers must have or learn if they are to make the most of their team.

The real craft, though, is learning to balance showing empathy while retaining a degree of authority in the workplace.

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**"We have delivered countless training sessions on empathy and simulated the kinds of conversations encountered in the workplace. Time and time again, we have seen the best technique to improve empathy in the workplace, and as a manager, is to practise."**

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We have delivered countless training sessions on empathy and simulated the kinds of conversations encountered in the workplace. Time and time again, we have seen the best technique to improve empathy in the workplace, and as a manager, is to practise.

For some this balance comes easily, but the majority of us will naturally lean to one side or the other. How effective your management style is, may well depend on where you work and whom you work with. You could have a team who respond very well to an extremely empathetic manager or, indeed, an autocratic one who shows little empathy at all.

But that's a risk and the balance can be easily undone especially if a new team member joins who requires a

different approach. Suddenly, you could find yourself on the back foot.

Showing empathy helps to:

- Foster a collaborative approach;
- Improve employee performance;
- Motivate staff;
- Support employees through changes in the workplace and;
- Make difficult conversations that little bit easier.

## Can you learn this balance?

There's no one solution to balancing empathy and being firm in the workplace, but it is possible to learn how to adopt a more empathetic approach.

There are signs you can learn to spot in colleagues and techniques you can develop that will help you to adjust your behaviour to get the best out of the individual personalities you work with – after that, it's all down to practice.

Think of it this way – it's like learning the difference between what you say and how you say it. You may say the right thing, but if poorly timed or voiced in the wrong way, it could be misinterpreted.

While empathy is a soft skill and based in emotion, there is a thinking side to it that you can learn and practice, which will enable you to begin to understand how your counterpart is feeling or what he or she is thinking.

This knowledge will help you learn how best to respond

to a situation, but it's practice that will help you to grow in confidence and be able to adapt your approach appropriately to improve outcomes.

### **Balancing empathy with authority starts with a few simple steps**

#### **Listen and observe:**

It's important to show that you are actively listening. Be sure to face the speaker and maintain natural eye contact wherever possible. Make sure you're attentive both to what they're saying and their body language but remember to stay relaxed.

Keep an open mind, and don't try to pre-empt the conversation with possible solutions. Listening carefully to the words being used will help you to picture what they are saying, a great technique to help you empathise with that person.

#### **Stop and think:**

Allow time to consider your contribution to the conversation and your responsibilities for the situation. Remember you are the manager here and you need to keep your own emotional state of mind in check.

#### **Listen some more:**

Explore deeper into their perspective and agree on a need for change in behaviour or working practice.

#### **Don't be distracted:**

It's all too common to see people checking their smartphone despite being in the presence of another human being. Be in the moment and give your full attention to the matter at hand.

#### **Be authentic:**

We all appreciate that praising staff is a proven tactic for improving performance and general well-being. But it needs to be genuine and relate to everyday performance and achievements rather than waiting for the completion of something significant.

This also means taking an interest in what your employees or team do – it all adds to understanding a team's well-being, but crucially helps you understand them.

#### **Be honest:**

Showing empathy doesn't mean you have to agree

with the other person. In fact, this is often where the true balance between being firm and being empathetic comes in – as long as you can show that you can understand where the other party is coming from and be mindful of their concerns, it's okay to steer them in a different direction.

### **But you must embed the learnings with practice**

We have delivered countless training sessions on empathy and simulated the kinds of conversations encountered in the workplace. Time and time again, we have seen the best technique to improve empathy in the workplace, and as a manager, is to practise.

Preparation is very important, but it's practice that will help you get the balance right and improve outcomes.

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**“When discussing empathy, it's easy to think of it as too “touchy-feely” for work, but empathy goes beyond just creating a pleasant or caring atmosphere in the office. It's an essential skill that managers must have or learn if they are to make the most of their team.”**

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What you actually say and what people hear can be two very different things. By practising real-life conversations (we call it [Realplay](#), utilising the expertise of our skills coach actors) where others won't be offended, you can experience the impact of your approach and learn how to adjust it from the immediate feedback you receive.

The more often you can practise empathy in Realplay or other interactive training sessions, the more confident and experienced you will become.

This allows you to be better prepared to respond and relate to others much more effectively. ■

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# Regulatory policy: The key ingredient of a healthy democracy

Céline Kauffmann, Deputy Head of the OECD's Regulatory Policy Division argues that regulatory policy is the key ingredient of a healthy democracy

**H**aving good-quality laws and regulations is essential. Regulation is one of the key tools at our disposal to influence behaviour, boost the economy, protect the environment, support consumers' rights and guarantee citizens' safety. Yet badly designed laws and regulations can be unduly intrusive, ineffective in reaching their goals and can curb entrepreneurship and well-being.

Through regulatory policy, i.e. the processes and institutions defining "the rules of rulemaking" across government, countries can significantly improve the design and implementation of laws and regulations, and therefore, regulatory quality. In an era of rapid technological change, unprecedented interconnected-

ness of economies and fear of "fake news", regulatory policy provides policymakers with tools to regain citizens' trust and address today's challenges. It is a key ingredient for a healthy democracy.

This is why in 2012 OECD countries adopted the OECD Recommendation on Regulatory Policy and Governance, the first-ever internationally recognised principles on regulatory policy. Ever since the OECD has been monitoring country practices in applying regulatory policy, the product key output of this monitoring is the Regulatory Policy Outlook. Published every three years, it provides comparative analysis and insights into emerging trends and challenges based on a unique set of indicators.



The 2018 Outlook shows that OECD countries have made progress in improving the quality of regulation. They have all adopted an explicit policy to promote regulatory quality across government. This is an improvement compared to 20 years ago when only 21 OECD countries had such a policy in place. Despite this progress, there is still much room for improvement. No country can yet boast to have reaped the full benefits of regulatory policy. Despite a strong rationale, regulatory policy continues to lag behind budget or tax policy in terms of attention that it receives from governments.

At the same time, trust in governments is waning. More than ever, policy action needs to address real issues and be driven by evidence. Greater and better stakeholder engagement can offer much-needed inputs to ensure that laws and regulations respond to these needs. It also helps increase the acceptance of regulations, in particular, when stakeholders feel their views have been listened to. Regulators and legislators also have powerful tools with regulatory impact assessment (RIA) and ex-post evaluation to gather relevant evidence on the costs, benefits and impacts of different policy solutions. However, the Outlook finds that both consultation and RIA are often used as bureaucratic “tick-the-box” exercises. Only five out of 36 countries systematically check whether regulations have achieved their goals.

In too many cases, the attention of policymakers is stuck in the design phase of laws and regulations – to show that they are doing something. But obviously, laws and regulations will only be effective if they are enforced and their spirit respected. Too few countries have today a clear policy and sufficient capacities for improving the implementation of regulations. Inspection agencies need to develop cost-efficient ways and risk-approaches to identify compliance problems and target their controls to the areas that are most at risk.

Governments cannot afford to continue regulating in isolation. They must consider their immediate surroundings and the broader international environment when making rules. No one country alone can address the consequences for its own population of the digital revolution, migration, of major environmental and financial hazards.

Almost any policy challenge, be it maintaining a sustainable environment, supporting global value chains, or guaranteeing the safety and privacy of citizens, is transboundary by essence and requires combined international efforts. Nevertheless, only a few OECD countries see the value in a systematic approach to international regulatory co-operation. Its consideration has to be embedded in the DNA of the administration.

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**“More than ever, policy action needs to address real issues and be driven by evidence. Greater and better stakeholder engagement can offer much-needed inputs to ensure that laws and regulations respond to these needs.”**

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Regulating in “normal times” can be a daunting task. With the ever-increasing pace of transformative technological change, governments face growing complexity and uncertainty in many regulated areas. Transformative technologies offer potential economic rewards, higher productivity growth, and improvements to living standards. They can also pose tremendous risks and a range of regulatory challenges, including social, environmental and economic.

Given the distinct potential of significant gains and losses, governments have to balance the adoption of innovative technologies and the management of the risks they pose. This requires, if anything, an even stronger use of regulatory tools, to pause and consider the consequences of their regulatory action. They can also tap into the wealth of opportunities that new technologies offer to consult better, gather more evidence, and ultimately to regulate better. ■

Reference: OECD (2018), OECD Regulatory Policy Outlook 2018, OECD Publishing, Paris, <https://doi.org/10.1787/9789264303072-en>.

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# Ensuring the consistent application and interpretation of EU law

The Court of Justice of the European Union was founded in 1952 to work with the Member States in ensuring the consistent application and interpretation of European Union (EU) law. Open Access Government finds out more about the excellent work they do

The Court of Justice is the judicial institution of the European Union (EU), responsible for reviewing the legality of acts of the EU's institutions, ensuring Member States comply with their treaty obligations and interpreting EU law at the request of national courts and tribunals.

The court is composed of 28 judges and 11 advocates general. Judges are appointed for a term of six years, which is renewable. They are chosen by common accord of the governments of Member States after consultation with a panel responsible for giving its opinion on prospective candidates. Judges' independence must be beyond doubt and hold qualifications for the highest judicial offices.

The judges of the court elect from among their number a president and vice-president, who serve renewable three-year terms. The president directs the work of the court and presides at hearings of the full court or the Grand Chamber.

## Koen Lenaerts, President of the European Court of Justice

Since October 2015, the role has been held by Belgian, Judge Koen Lenaerts. Lenaerts obtained a candidate in law (summa cum laude) in 1974 from the University of Namur, followed by licentiate in law (summa cum laude) at the Catholic University of Leuven in 1977 and a Master of Laws degree at Harvard Law School in 1978. He became a Master in Public Administration at the John F Kennedy School of Government at Harvard in 1979 and in 1982, obtained a PhD in law from the Catholic University of Leuven.

Since 1983, he has been Professor of Law at the Catholic University of Leuven and has also served as Professor at the College of Europe in Bruges, Visiting Professor at Harvard Law School and Judge at the Court of First Instance of the European Communities.

He became a judge at the Court of Justice in October 2003 and was elected Vice-President of the Court between 2012 and 2015.

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**“Since October 2015, the role has been held by Belgian, Judge Koen Lenaerts. Lenaerts obtained a candidate in law (summa cum laude) in 1974 from the University of Namur, followed by licentiate in law (summa cum laude) at the Catholic University of Leuven in 1977 and a Master of Laws degree at Harvard Law School in 1978. He became a Master in Public Administration at the John F Kennedy School of Government at Harvard in 1979 and in 1982, obtained a PhD in law from the Catholic University of Leuven.”**

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Over the years, the court's case law has established a number of fundamental principles.

## Community law in the Member States

In 1963, the case of *Van Gend & Loos* introduced the principle of the direct effect of community law in the Member States, which now enables European citizens to rely directly on EU law before their national courts.

*Van Gend & Loos* was a transport company that imported goods from Germany to the Netherlands and had to pay customs duties it considered incompatible



with the EEC Treaty prohibiting increases in duties on trade between the Member States. Following a referral by a Dutch court, the Court of Justice decided the company had a direct guarantee of its rights under community law before the national court.

A year later, the Costa judgement, involving an Italian court asking the Court of Justice to decide whether a national law on nationalisation of the production and distribution of electrical energy was compatible with the EEC Treaty, established the primacy of community law over domestic law.

Another fundamental concept was established in 1991. In *Francovich & Others*, two Italian citizens who were owed pay by their insolvent employers brought actions for a declaration that the Italian state had failed to transpose community provisions protecting employees in the event of their employers' insolvency.

The court stated that the directive in question was designed to give individuals rights that they had been denied by the state's failure to implement it. This established the principle of the liability of Member States to individuals for damage caused by a breach of community law by that state.

### **The uniform application of laws across all 28 Member States**

The Court of Justice also works with national courts and tribunals called upon to decide a dispute involving EU law. National courts can, and sometimes must, submit questions to the Court of Justice for a preliminary ruling. It then provides its interpretation of or reviews the legality of, a rule of EU law.

The development of its case law demonstrates the court's work in creating a legal environment to protect the rights of citizens under EU legislation and to ensure the effective and uniform application of those laws across all 28 Member States. ■

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# Law and Language: Understanding multilingual EU Law

In the first of a series of five articles exploring the phenomenon of multilingual EU law, Dr Karen McAuliffe, PI on the European Research Council funded project 'Law and Language at the European Court of Justice', explains the importance of taking language into account when thinking about law

**L**aw permeates almost every part of our lives. 'The law' governs what we can and can't do in a society, regulating our rights and duties at local, regional, national and international levels. Often, non-lawyers (and indeed some lawyers) view the law as a definitive set of rules, perhaps somewhat complicated to navigate without specialist advice, but clear and precise, nonetheless. However, examining the process and production of law through the lens of language allows us to understand 'the law' in a very different way. Language and law are inextricably linked – the law is an inherently linguistic construct: it is largely created, interpreted and applied through language. Language is, therefore, an extremely important part of, and has a significant impact on the development of any legal order.

While this link between law and language exists across all legal orders, at every level, it is more visible and arguably more important where the law in question is multilingual. In today's globalised world, multilingual law permeates many aspects of our daily lives and is more important than ever before. The intense process of globalisation in the latter half of the 20th century has led to a rapid increase in the production of international treaties and agreements, the creation



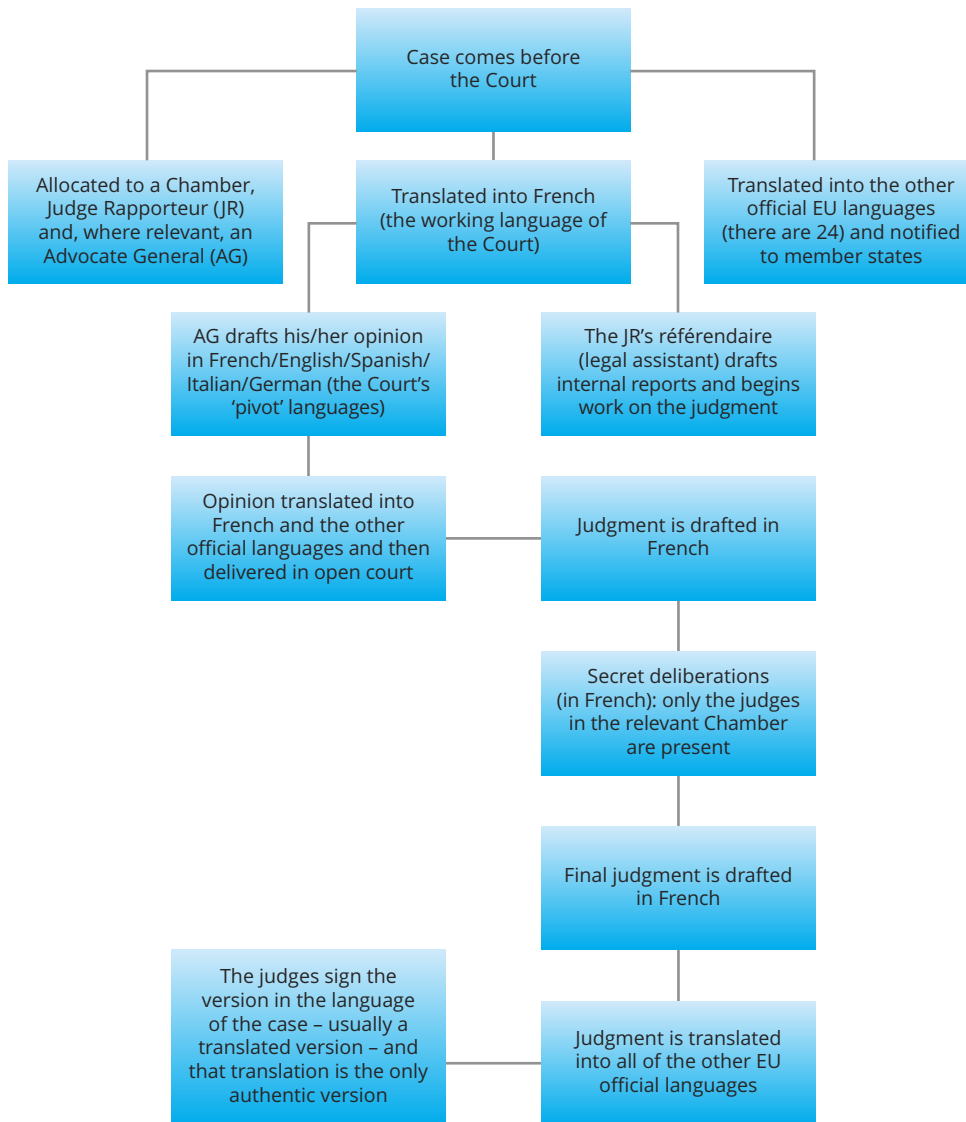
of international courts as well as a reliance on international arbitration.

Much of this globalised legal work is performed through translation and much of the underpinning law on which such work is based exists in a multi- or pluri-lingual sphere. Nowhere is this phenomenon of multilingual law more evident than in the context of the European Union, which produces law in 24 languages, with the aim of it being applied uniformly throughout (at the time of going to press) 28 member states.

The EU's multilingual law consists of treaties, as well as secondary legislation (regulations, directives, decisions etc.), all of which are considered equally authentic in each of the 24 EU

official languages in which they are produced. The multilingual nature of that legislation is generally evident to those coming into contact with such documents on a regular basis.

However, there is another source of EU law, the multilingual nature of which is not always so obvious: decisions of the Court of Justice of the European Union (CJEU). When a member state or other legal party to an action before the CJEU engages with that court, it does so in its choice of one of the 24 EU official languages. Since all correspondence in relation to the relevant action, including notification of the 'authentic version' of the judgment, is carried out in that one language, the multilingual nature of the process behind the scenes is not always apparent. However, given the



importance of CJEU case law as a source of EU law, its multilingual nature should not be ignored.

Although the CJEU produces case law in up to 24 language versions, it has a single working language: French. On the surface, that court is, in effect, a monolingual institution: working internally in French and producing translated case law in up to 23 languages. However, within that surface-level 'monolingualism' are layers of hidden translation. CJEU judgments are drafted by multiple authors in a language that is generally not their mother tongue. They then go through many permutations of translation into and out of up to 23 other languages. The final version of a judgment is a collegiate document and the authentic version of that judgment

will usually be a translation. Exploring that multilingual production process and what it might mean for our understanding of EU law is the focus of an EU Seventh Framework Programme (FP7) project entitled 'Law and Language at the European Court of Justice' (LLECJ), based at the University of Birmingham, UK.

Based on the theoretical assumption that a linguistically 'hybrid' community, such as that of the CJEU, functions primarily through language interplays, negotiations and exchanges; and that the 'process' within any institution will necessarily affect its 'output', the LLECJ project investigates the cultural and linguistic compromises at play in the creation of the CJEU's multilingual case law. The project aims to shed

greater light on the development of EU case law and consequently on EU law more generally, by taking account of the multilingual nature of that law. By clarifying the ways in which language plays a key role in determining judicial outcomes, we can challenge EU scholarship to look beyond more conventional approaches to the development of a rule of law which draw on law alone, and develop a fuller and more nuanced understanding of the phenomenon of multilingual EU law. The LLECJ project is comprised of three separate but interlinked subprojects investigating: the limitations of producing a multilingual jurisprudence; the linguistic construction of de facto 'precedents' in CJEU case law; and the linguistic aspects of the role of Advocates General at the CJEU. More information about the project, including publications and reports, is available on the LLECJ website: [www.llecj.karenmcauliffe.com](http://www.llecj.karenmcauliffe.com)

This article is the first in a five-part series focusing on the LLECJ project and examining the phenomenon and impact of multilingual EU law. Forthcoming articles will examine certain research questions posed and results obtained in specific subprojects and will explore what such results may mean for our understanding of EU case law and EU law more generally.



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- Separation of heat in reversible and irreversible parts; and
- Ageing studies.

## Abuse condition tests include:

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- 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.

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or email: [info@realisefuturesecofurniture.co.uk](mailto:info@realisefuturesecofurniture.co.uk)

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