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THE FUTURE OF EUROPE: THE EURO 276

EVA MAYDELL MEP, GROUP OF THE EUROPEAN PEOPLE'S PARTY (CHRISTIAN DEMOCRATS) SHARES HER INTERESTING VIEWS ON THE FUTURE OF EUROPE, FOCUSSING ON ITS MOST SYMBOLIC ELEMENT, THE EURO

IN THIS ISSUE

REINVENTING THE COMMUNITY

building on creativity

Creativity, innovation and a strong focus on social and cultural aspects of sustainability are at the very heart of developing the Municipality of Varberg to become the Swedish West Coast's Creative Hot Spot by 2025.

In our vision for the future, the municipality has unique opportunities. The city of Varberg is one of the most attractive cities in Sweden, ideally located with the city centre right next to the coastline. Our location is exceptional – right in between two of Sweden's fastest growing regions, The Greater Gothenburg region, and the Greater Copenhagen region.

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The Municipality of Varberg has been appointed Sweden's Best Place To Live in the category of smaller communities for four years in a row now. Our thriving city centre was winner in Sweden's City Centre of the Year award. And living in the wonderful coastal province of Halland, it is certainly very fitting that the yearly Varberg event Hallifornia was awarded 2017 Placebrander of the year. We are proud of these awards and regard them as appreciative of our chosen path towards the future.

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FOREWORD

Luca Jahier
EESC President
European Economic and Social Committee (EESC)

The European Union has created a strong Single Market with all the laws and rules that come with it, it has created a common currency and has removed barriers and borders, but we are still far from having created the people's union our founding fathers had in their mind and in their heart at the end of the Second World War.

What is missing is a true sense of ownership and belonging. This missing element in the European construction has opened a vacuum, which populists have easily filled, helped by the growing sense of uncertainty and inequality.

As the newly elected president of the European Economic and Social Committee (EESC), I want to focus on these missing links, which are so badly needed to restore a sense of trust and confidence towards the future. From sustainable development to the promotion of peace, so often taken for granted, to giving young Europeans a voice and last but not least to strengthening the role of culture – giving artists and intellectuals the place they deserve to re-energise the EU.

It's the culture, stupid!

Culture is a broad topic and I will look at it from different angles, not least to show the importance and influence of culture on societies.

Culture in its broadest sense defines our ways of living. It encompasses a society's customs, traditions and values – a system of rules and habits that guide people's coexistence and behaviour.

In this sense, culture is the glue that binds a society together. Like gluing – one of the oldest techniques for holding things together, culture has changed and developed over the centuries, but its function has remained the same, namely to keep society together.

Today, with extremism increasing unabated, with citizens questioning their common European identity more than ever since 1945 and with solidarity within Europe fading, it is time to firmly place culture and cultural policies at the heart of the European agenda.

One of the main challenges facing Europe is the influx of people from different cultural backgrounds. People have been moving across the continent for many centuries and this mobility has enriched our nations. To ensure that the current migration wave is also a success and enriches both our societies and the new citizens, we need to steer it in the right direction.

Education will be key, particularly learning the language of the host country, since integration is only possible when one speaks the language of the society he/she wishes to join.

But we also have to be clear about our values: while we resolutely defend freedom of speech and freedom of religion, we cannot accept their misuse. Demagogy, propaganda and authoritarianism should have no place in our society and nor should religious segregation.

The values of the French revolution – freedom, equality and fraternity lie at the core of Europe – but Europe also stands for tolerance, solidarity and humanity.

Unfortunately, these values are not obvious to everyone and people need to be reminded of them and required to comply with them. A move towards an illiberal democracy with restrictions on citizens, however, is the wrong approach. Rather, we need to be much clearer on our values and on what Europe is all about.

We must not forget that one of the main aims of the European Union is to "promote peace, its values and the well-being of its peoples" (Article 3 TEU).

The promotion of culture as a pillar of peace and stability must go hand in hand with freedom of artistic expression as a human right and with support for global initiatives that protect artists' rights. Culture based on the extraordinary richness generated by diversity will inevitably help combat populist tendencies and state-led cultural propaganda, build bridges between peoples, tear down walls that are appearing in ever-greater numbers, repair growing prejudice and open opportunities for closer cooperation and dialogue.

From a narrower point of view, culture comprises expressive forms such as architecture, painting, poetry, music, dance, ritual, religion, etc.

Europe has a rich and diverse cultural heritage – as diverse and impressive as its history. It is an asset that cannot be praised often enough, and we must be proud of it. People all over the world envy us for this wealth. So much so that other countries try to reproduce European cultural sites – like China, which has replicated not only the small Austrian town Hallstatt in its Boluo County but also several European castles and the Eiffel tower.

Europe has given birth to many great political thinkers, philosophers and scientists who are still influential today. From Greek antiquity through the Roman Empire to a new peak in the Renaissance and the current period – Europe stands for culture. And it is our task to support and harness culture in order to maintain its impact.

I am, therefore, delighted that the EU has decided to proclaim 2018 the European Year of Cultural Heritage.

Culture is not only the driver of European identity; it is also a very important economic factor. Indeed, it is the EU's third-largest employer, following the construction and beverages sectors. Cultural and creative industries are dynamic and innovative by nature and as such, their innovation potential can also benefit other areas of business.

Cultural and creative industries or CCIs (core industries and those that are heavily dependent on them) contribute nearly 7% of European GDP.

Europe cannot neglect these industries and the European Economic and Social Committee has already addressed this subject in several of its opinions. In fact, the EESC recently published a study which offered five key recommendations for cultural players and political decision-makers to boost CCIs.

Among other things, the EESC calls for a common strategy on culture to preserve our cultural sites for the future, but also to use them for commercial purposes and thus create jobs and income for many people.

Culture is a unifying and mobilising force. It is a vehicle for economic growth, a means to revive cities and regions, a tool for integration and inclusiveness and an effective instrument of 'soft power' in external relations.

I am convinced that culture can offer many more keys enabling people to come closer to our unique European construction, live in peaceful and tolerant co-existence and it must, therefore, be placed higher on Europe's agenda. It's culture, stupid! ■

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OPEN ACCESS

INTRODUCTION

A very warm welcome to the July 2018 edition of Open Access Government.

Heading up the health & social care overview section, Paul De Raeve, Secretary General and Elisabeth Adams, President of the European Federation of Nurses Associations (EFN), tell us why the European Pillar of Social Rights should help nurses to remain in the nursing profession. Also, in this section, the Huntington's Disease Society of America explores the sources of funding in the development of therapies for Huntington's disease (HD).

One of the in-depth health focus areas covered in this journal is diabetes, which includes an article by Professor Nam H. Cho, President of the International Diabetes Federation (IDF), who writes about the rise of diabetes across the globe. Another perspective in the section includes Kimberley Hanson, Director of Federal Affairs at Diabetes Canada, who argues that the country urgently needs a national strategy to tackle the diabetes epidemic.

In research & innovation, we are thrilled to have a prestigious contribution by Dr Juan C. Meza, Division Director for the Division of Mathematical Sciences (DMS) at the National Science Foundation (NSF), who reveals why mathematics is such a powerful tool for understanding the world around us. Also, in the space policy section, we include a special interview with Johann-Dietrich Wörner, Director General of the European Space Agency (ESA) who imparts his views on ensuring a globally successful European space sector.

This publication also features a number of insightful policy articles from current Members of the European Parliament (MEPs), including Eva Kaili, Rapporteur of the European Parliament of the Blockchain Resolution, who explains her thoughts on blockchain technology in the European Union (EU). Another key policy article comes from Eva Maydell MEP, Group of the European People's Party (Christian Democrats), who shares her interesting views on the future of Europe, shedding light on its most symbolic element, the Euro.

In the environment section, Keith Taylor MEP, Green Party Member from the European Parliament for the South East region in the UK details his opinions on the importance of protecting the UK's environment post-Brexit, including air pollution – a public health crisis which is linked to the premature deaths of over 40,000 Brits each year.

Finally, one other highlight is a fascinating interview with Sweden's Minister for Policy Coordination and Energy, Ibrahim Baylan. It was a pleasure to speak to him about his government's priorities for developing the sustainable energy solutions of tomorrow – including the country's aim to become one of the first fossil-free welfare societies in the world.

I hope that you find a wealth of thought-provoking reading in this informative July edition of Open Access Government. Do not hesitate to get in touch with me if you would like to contribute an opinion piece for any future editions of this publication. ■

Jonathan Miles
Editor

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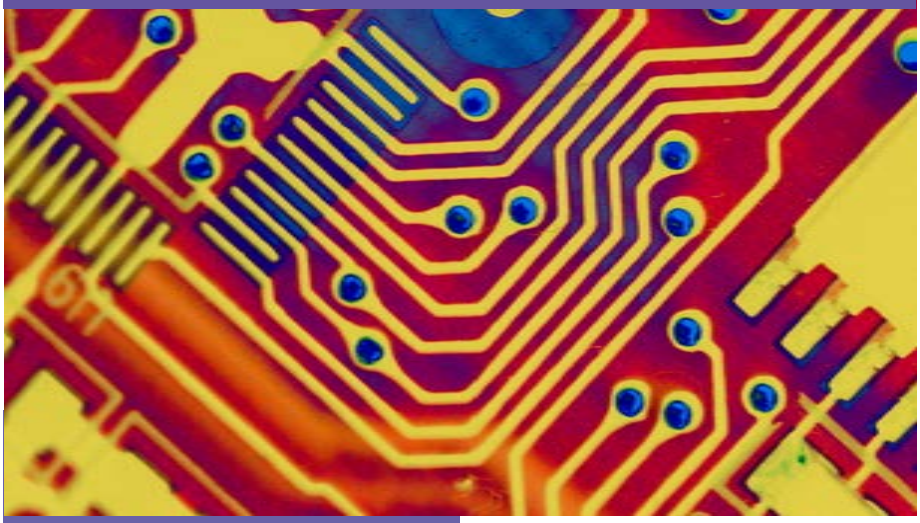

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Why the European Pillar of Social Rights should keep nurses in the profession

Paul De Raeve, Secretary General and Elisabeth Adams, President of the European Federation of Nurses Associations (EFN) tell us why the European Pillar of Social Rights should help nurses to remain in the nursing profession

During the last World Economic Forum in Davos, the United Kingdom (UK) shadow chancellor, John McDonnell, states that: "Ten years after the financial crash, with ten years of austerity and ten years of paying their taxes and seeing public services cut, people have had enough". He strongly calls to: "Pay your workers a living wage". This statement captures what European Federation of Nurses Associations (EFN) has been advocating for years: "Keep the nurses in the profession by providing reasonable working conditions and decent pay".[1]

EFN has monitored the impact of the economic crisis on nurses and the nursing profession since 2008 across Europe. In the analysis, it is evident that the negative impact on nurses and the nursing profession has demonstrated serious consequences for health systems outcomes, not only with regards to the safety and quality of care but the attrition in significant numbers of nurses leaving the profession. Ten years later, doing more with less, has created increased unsustainable workloads with a high price being paid for employees and employers.

Furthermore, financial cuts and regressive spending review policies have shaped a new austerity environment within the European Union (EU), that focused and was over-dependent on meeting financial and economic targets, rather than defending the values that constitute the fundamental principles of the European project: prosperity for all.

The number of nurses leaving the profession has become an alarming indicator for the negative consequences and the deteriorating health outcomes that are evident in the EU health system: for instance, the Belfast Telegraph reported[2] that just under 600 nurses left the Northern Ireland NMC register in 2013/14. The figures increased to 928 in 2016/17, while a further 506 left the register in the first two- quarters of 2017/18. In parallel, the number of nursing vacancies increased by over 8% in 2017, from 31,634 to 34,260. But the Northern Ireland case is only one example; for Belgium, the nursing profession is the first listed profession in 2018 with the highest vacancies. In Belgium, over the past four years, significant numbers of nurses have left the profession while ironically this country is leading an EU Project on workforce planning and forecasting. Demonstrating a serious dichotomy between theory and practice that is replicated across the EU and its Member States.

"We are losing our frontline nurses while civil servants are planning and forecasting! We need to act now to limit the damage."

Therefore, the answer to the question: "Why do we keep failing to have 'enough nurses'?" is simple: "Because we keep undervaluing the importance of nurses' contribution."

EFN nursing leaders warned that the situation will deteriorate in 2018-2019 as nurses' face some of the most difficult working conditions in living memory. With the current pressure on the workforce, the shortages and the substandard workplace environments, which includes physical and verbal violence and abusive behaviour while nurses deliver essential and lifesaving care, the relentless negative pressures have become unbearable for nurses and therefore, they are forced to walk away from the profession to protect their own health and family. Consequently, nurses' trust in Europe's ability to shape their future and to

deliver both fair and prosperous societies has been eroded since 2008.

It is, therefore, imperative that the European Pillar of Social Rights provides effective hard and soft law initiatives and frontline incentives to retain the nurses in the profession.

EU efforts to achieve social convergence

In the attempt to respond to the well-known social challenges, the Juncker Commission presented some initiatives aiming to boost the social dimension of Europe. In this context, the reflection paper on the social dimension of Europe[3] developed by the European Commission in April 2017 examines how to sustain our standards of living, create more and better jobs, equip people with the right skills and create more unity within our society, as well as adapting our social models to current and future challenges and to galvanise Europe's social spirit. The document acknowledges that much still needs to be done to achieve a social convergence between European countries in Europe.

The reflection paper sets a timeline for Social Europe, that includes the design of the European Social Rights Pillar, the main goal of which is to act as a driver for social change in Europe and serve as a guide towards efficient employment and social outcomes. The 20 principles enshrined in the Social Pillar aim to address crucial topics, such as equal opportunities and access to the labour market; fair working conditions and; social protection and inclusion[4].

But how do we ensure that such ambitious the European Pillar of Social Rights principles turn into concrete support for three million frontline nurses in the EU? Or is this not what the EU is about?

To deliver on these initial objectives, the Social Pillar must be developed for people and with people. Therefore, it is crucial to ensure that its implementation, as a primary objective with the drive to improve the life and well-being of EU citizens, including the valuable and essential human resource of the three million nurses, by concretely engaging in its co-design and implementation. Council recommendations are not

enough in isolation, indeed frontline action implementing political agreements and commitments are an absolute requirement. Therefore, to achieve real frontline change, under the Pillar principles of "access to health care" and "work-life balance and wages", clear proactive priorities and actions with the support of the nursing profession have the potential to make a significant difference for all the citizens of Europe. Investing in nursing is a positive investment in the quality of life and the well-being of all.

Access to health care

Related to Chapter III of the European Social Pillar, social protection and inclusion, the principle 16 "access to health care" is the core business of all EU nurses. The right of everyone to timely access, affordable, preventive and curative healthcare of good quality, emphasising the importance of long-term care, becomes a key societal challenge in the EU. This needs to be addressed, with an urgent re-focus on 'moving care back to the community[5], by designing in partnership with the nurses, a more holistic approach to value-based healthcare. Due to the close relationship nurses nurture naturally with citizens and patients that considerably contributes to the implementation of a people-centred approach, co-designing is the only way forward. However, barely 3% of the health budget goes to prevention, a sector that heavily suffered during the 2008 economic crisis, leading to worsening statistics on all key indicators across every public health topic.[6]

Within this context, it is important to recognise the contribution of nurses' in combatting the main challenges that European health systems are facing, for example, the increase of people living with multi-morbidity and chronic diseases, antibiotic resistance (AMR) and a lack of trust in vaccinations, all conditions that not only have negative health outcomes for the whole community across Europe, but increase the workload of the frontline nurses, which in turn risks nurses leaving the profession which has serious implications in a people-centred approach model. It is, therefore, central to invest in and develop an efficient primary and community care system, which is considered to have crucial added-value in terms of moving care back to the community, boosting the social economy and becoming a driver of well-being, productivity and growth.

However, this model of care delivery requires a deep change of mindset and the paradigm shift of those writing and signing off public health and workforce policies. However, co-design is one solution to reduce the policy and reality divide to make a real difference on the frontline. There are many successful examples of nurses' co-design in delivering primary care through e-health services: nurses' close relationship with citizens/patient place them in an ideal position to consider all the physical and social factors that influence an individual's health. These are the essential preconditions that make prevention work, with nurses becoming the natural leaders in reforming health systems, moving from cure to care, from therapy to prevention. In this sense, nurses working in primary care centres, schools, in the community and, not least as informal carers in their own families, are in a unique position to perform advanced roles to increase the accessibility to prevention and care[7].

Improving timely access to affordable health and social care is also ensured by the support that nurses provide in bringing the population closer to digital innovations that are reshaping our healthcare systems. It is within this context that nurses act as coaches, introducing and guiding many European citizens/patients to e-health services that are fit for purpose. It is within this context that nurses' advanced roles in blockchain technology will smooth access to the personalised electronic health records and as such, ensure it all works more effectively and efficiently. The ENS4care prevention guideline, developed with industry and civil society, is a good example of upscaling innovation to combat ongoing austerity in the health sector.

To guarantee the delivery of safe healthcare of good quality, the EU and national policies should improve their focus on the features that make healthcare systems communicate more efficiently. With the endless EU efforts on interoperability and semantics, still, today discharged patients struggle with the 'integrated model of care' and 'continuity of care'. Therefore, the Social

Pillar should support nurses in leading the transition towards an integrated care model through measures that acknowledge and emphasise the frontline responsibility in ensuring continuity of care. To make this vision a reality, a new mentality concerning the health and specifically, the nursing workforce must be embraced. National governments should immediately reverse the focus from only planning and forecasting and collecting mainframes full of data, towards supporting frontline nurses to prevent them leaving the nursing profession due to unsustainable workloads and poor working environments. The European Social Pillar should focus on the harmonised development of the advanced nurse practitioner (ANP), to better address the unmet health needs of the European population.[8] This means boosting the first principle of the Pillar: education, training and life-long learning.

"Improving timely access to affordable health and social care is also ensured by the support that nurses provide in bringing the population closer to digital innovations that are reshaping our healthcare systems. It is within this context that nurses act as coaches, introducing and guiding many European citizens/patients to e-health services that are fit for purpose."

Education – Advanced Nurse Practitioner (ANP)

The Social Pillar Chapter I – equal opportunities and access to the labour market, education, training and life-long learning – has been key for EFN since 1971, when the discussion on the nursing education and free movement started to take place.[9] The contribution of the nurses to the EU policy process, especially related to the free movement of nurses within the EU, resulted in the Directive 2005/36/EC, modernised by the Directive 2013/55/EU and importantly, in the co-design of the Proportionality Directive, that concerns strengthening nursing as an independent profession in the EU. That independence in coordinating and delivering care is a significant contributing factor to nurses staying committed to their profession.

Therefore, the Social Pillar should build its developments on these EU legislative successes of 50 years in European Commission DG Internal Market, Industry, Entrepreneurship and SMEs (DG GROW). It is only by ensuring through education and training – the right skill-mix and a sustainably designed workforce composition[10] that nurses can qualitatively contribute to increasing the access to health and social services for EU citizens. To this purpose, the bachelor programme as harmonised by the European Directive 2013/55/EU and specifically article 31, needs to create a complementary and harmonised EU education programme for ANP, building on and going beyond the eight competencies as set out in Directive 55. To make integrated care and continuity of care a reality throughout the EU, it is particularly important that advanced nurse competencies highlight the importance of managing care throughout the system. With progressive developments, such as e-skills making the digitalisation of health and care a fact, supporting people and healthcare professionals communicate flexible and optimal in the people-centred system is the future reality of effective and efficient healthcare. As such, blockchain technology[11] can become a support for nurses when technology starts collecting the data needed to move towards a value-based health system, where outcomes define the financing methodology. The Social Pillar should, therefore, provide not only the basic ingredients to start implementing continuity and people-centred care, but it needs to provide the supporting framework and the concrete tools for the nursing workforce to close the existing EU implementation gap.

Work-life balance and wages

Related to Chapter II – fair working conditions, work-life balance is a key principle for nurses to stay in their profession. Nurses with caring responsibilities have the right to suitable leave, flexible working arrangements and most importantly, safe environments with specific attention paid to the increasing violence against nurses in different working settings, in both the hospital unit and the community. Nurses have the right to a high-level protection of their health and safety at work, to allow them to remain in the nursing profession for as long as possible. Ensuring that these conditions are met should be a key incentive in the Social Pillar.

The Pillar should include measures to respond to nurses needs as professionals, recognising that 92% of the workforce is female, performing a high-risk, high-skilled job with inappropriate recognition and reward. Good examples of national legislation exist, for instance in Belgium, where since 1993, the country introduced a financial system incentive for frontline nurses: at 45 years, one extra compensation day/month, at 50 years, two and at 55 three extra days off per month, with the option to choose between an increase in the salary or extra days off. This system has proven to be a measure keeping nurses in the profession and valuing their tuff frontline work.

As more good practices exist in the EU, the Social Pillar should scale them up and allocate EU funds to the Pillar and as such, recognise the high-risk job of nurses. The nursing profession needs and expects from the European Social Pillar, a coherent implementation of what already exists and has proven to be successful, aiming to bring an overall EU improvement to several aspects related both to professional and personal features of the profession. Only by incorporating nurses' needs, utilising and maximising the use of their skills and engaging them in the co-design and implementation of social and healthcare policies, the Pillar will enable nurses to carry out their mission to prevent diseases, deliver high-quality and safe care and enhance health and social care throughout the EU.

Fair working conditions also include the right to fair wages that provide for a decent standard of living, but this is not always the case for nurses, for whom meagre salaries and demanding hours are making the profession too hard to stay in. Although, since 2004, the 15 countries who joined the EU – complying with the Acquis related to the education of nurses (Directive 55) – have registered an improvement with salaries of nurses going up from €250 to €780 net a month (Poland), nurses wages in all EU Member States are way too low compared to other professions, taking into account the huge risks nurses take when delivering care and the enormous positive difference they make to health and social care delivery.

In addition, a significant wage disparity within Europe leads many nurses to leave their own country in search of better conditions abroad, but this causing serious shortages in several countries. The expression, "Peter robbing Paul" is not new and the European Social Pillar should examine the wage issue urgently, to both attract and retain nurses into the nursing profession.

Reflecting again to the words of John McDonnell: "Pay your workers a living wage", the European Commission needs to investigate what decent pay means for nurses, compared to other professions, like teachers, firemen/women, policemen/women for example – this is an exercise that does not require nurses' wages to be compared with doctors', as the differences are already well known. However, when reforming health systems, by introducing advanced nursing practitioners and nurse-prescribing, it could be interesting to know how to increase accessibility and at the same time, making EU health systems resilient.

Conclusion: Make the European Social Pillar work for 3 million nurses!

Considering the increasing pressure faced by European healthcare and social systems today, it is central to invest in a motivated and skilled nursing workforce who are delivering frontline care. Addressing the unmet needs of nurses throughout the EU cannot be further postponed, with the situation for nurses deteriorating beyond terrible levels, impacting on their ability to deliver appropriate safe and quality care, and as such, many nurses have no choice but to leave the profession. Without the appropriate and timely policy measures from within the EU Social Pillar, nurses will become difficult to recruit and to retain in their job. Anyone who has ever experienced, either as patient or relative, the need for receiving healthcare, know that without nurses, such highly qualified services could no longer be provided.

However, to enable nurses to deliver on a key priority such as access to health and social care, it is fundamental to substantially improve nurses' wages and working conditions, both of which are already over-stretched, leading to burnout and increase of sickness days in each Member States. For EU citizens, including three million nurses, 'enough is enough'! There is a real tangible opportunity with the Social Pillar to make a significant difference, but there needs to focus on nursing workforce policies that promote an integrated level of and a continuity of care, with advanced nurse practitioners and nurse prescribing deployed throughout the EU, engaging local frontline nurses, co-designing 'fit for purpose' health and social care systems. ■

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Modernising health policy, building up knowledge and tackling preventable diseases

The work of Vytenis Andriukaitis, European Commissioner for Health & Food Safety, with responsibility for modernising health policy, building up knowledge and tackling preventable diseases is explored here by Open Access Government

Vytenis Andriukaitis has been European Commissioner for Health & Food Safety since 2014. After practising as a doctor and surgeon in his native Lithuania, he played a prominent role in the country becoming the first republic to break away from the Soviet Union in 1990, signing the act of independence and acting as a co-author of its constitution.

Andriukaitis founded the LSDP, the Social Democratic Party of Lithuania and twice served as a member of parliament, becoming Minister for Health between 2012 and 2014. As Commissioner, his responsibilities include modernising and simplifying EU food safety policy.

He is also responsible for ensuring the European Commission is ready to support the EU's capacity to deal with crises in food safety, or pandemics and for reviewing laws that oblige the Commission to authorise genetically modified organisms (GMOs), even when a majority of national governments oppose them.

The Commissioner also works to build up knowledge of the performance of countries' health systems to help shape policy and to help address the challenges of increasing demands on health services at a time of intense pressure on resources.

In April, Andriukaitis appeared before the European Parliament's Committee on Environment, Public Health & Food Safety to provide an update on the action taken by the Commission in the areas of food safety, vaccination and eHealth. In particular, Andriukaitis said, the Commission has taken important steps towards completing the Digital Single Market Strategy for EU citizens.

A newly adopted communication on the Digital Transformation of Health and Care seeks to address "significant challenges" in realising the benefits of digital opportunities in health. The communication focuses on three pillars. Firstly, ensuring patients' access to their data and the ability to share this data with doctors. The communication supports the eHealth Digital Service Infrastructure, which has seen 22 European Union member states to commit to exchange patient data by 2022.

Vytenis Andriukaitis

Image: © European Union, 2018

The European Commission will also develop a European Electronic Health Record Exchange Format to expand the exchange of data. Furthermore, the role of the eHealth Network of Member States in governing this exchange will be formalised to enable healthcare providers and patients access to medical data across borders.

The second pillar focuses on connecting the disparate big data being created by new health devices and technologies to advance research, prevention and individualised care.

As a first step, on 10 April, 16-member states signed a declaration to build a research cohort of at least one million sequenced genomes. Accessible by 2022, this will build on existing initiatives in precision medicine.

The third pillar focuses on fostering "person-centred" care. The communication considers actions to support mobile health and telehealth as part of new models that will allow people to play a greater role in their own care.

"For me, digital technologies are part of a health policy 'reform package', which includes the necessary changes in training, organisational structures, financing and incentives," Andriukaitis told the committee.

"Embracing these technologies in a secure, strategic and coordinated manner will enable the health sector to reap the benefits of the digital revolution."

Another key priority for the Commission is supporting stronger EU cooperation against preventable diseases. In April, the Commission issued a set of recommendations to achieve this by improving vaccination coverage.

Vaccination is estimated to save between one and three million lives worldwide every year and, according to WHO forecasts, will save another 25 million during the coming decade.

However, according to the European Centre for Disease Prevention & Control (ECDC), several EU countries face unprecedented outbreaks of measles and a resurgence of other preventable diseases due to insufficient vaccination coverage.

Between 1 March 2017 and 28 February 2018, 14,813 cases of measles were reported through the European Surveillance System. Where vaccination status was known, 86% of cases were unvaccinated. In addition, the ECDC estimates that at least 40,000 people die every year from influenza, partly due to low vaccination coverage.

The Commission's proposal focuses on three areas: tackling "vaccine hesitancy" and improving coverage; sustainable vaccination policies in the EU; and EU coordination and contribution to global health.

It calls for 20 actions by the Commission and member states, including implementing national and/or regional vaccination plans by 2020, establishing a European vaccination information portal by 2019 and establishing European Information Sharing System to gather knowledge and develop guidelines for a core EU vaccination schedule by the end of the decade.

The Commission's proposal for a council recommendation will be discussed by the council with the aim of seeing it adopted before the end of 2018.

"A newly adopted communication on the Digital Transformation of Health and Care seeks to address "significant challenges" in realising the benefits of digital opportunities in health. The communication focuses on three pillars. Firstly, ensuring patients' access to their data and the ability to share this data with doctors. The communication supports the eHealth Digital Service Infrastructure, which has seen 22 European Union member states to commit to exchange patient data by 2022."

"Vaccination is one of the most powerful and cost-effective public health measures developed in the 20th century," Andriukaitis says.

"As a medical doctor, I find it disheartening to witness children dying because of low uptake, vaccine hesitancy or vaccine shortages. Infectious diseases are not confined within national borders. One-member state's immunisation weakness puts the health and security of citizens at risk across the EU. Cooperating in this area is in all of our interests." ■

https://ec.europa.eu/commission/commissioners/2014-2019/andriukaitis_en

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Inter- and transdisciplinary research on yam systems for improved food security in West Africa

Professor Emmanuel Frossard from ETH Zurich and his collaborators from Switzerland and West Africa experiment in the YAMSYS project, a novel approach for improved soil and crop management in yam systems

Whereas food insecurity has decreased in West Africa, it remains a major problem. Many projects aiming at improving agricultural productivity failed to deliver sustainable solutions because they were not sufficiently considering the needs and local knowledge of stakeholders. If we want to contribute to meeting the second sustainable development goal (zero hunger), we need to develop soil and crop management options which are not only relevant from a technical point of view but which also fit stakeholders' needs.

Image: © VK Hogza

White yam (Dioscorea rotunda) growing on an innovative staking system developed within the YAMSYS project

The YAMSYS project addresses these issues in Côte d'Ivoire and Burkina Faso using yam (*Dioscorea* spp) as a model crop. The project is conducted in an inter- and transdisciplinary manner by scientists from natural and social sciences from Switzerland and West Africa together with stakeholders from the studied sites. The following text explains the importance of yam and how YAMSYS will reach its aims.

The importance of yam for food security and challenges in yam production

The yam belt spanning from Cameroon to Côte d'Ivoire makes up about 90% of the world yam tuber production. Yam tuber provides 200 to 500 kcal per day per capita in the yam belt and is also a significant source of protein and micronutrients for human beings.

However, traditional yam cropping practices are not sustainable and farmers' tuber yields are often lower than 10 tha^{-1}. Yam is usually planted as the first crop after slash burning forests or long-term fallows leading to a decrease in biodiversity. Yam is seldom fertilised, leading to nutrient mining. Farmers use a large fraction of harvested tubers as planting material (yam seeds) for the next season, limiting the number of tubers that can be sold or eaten. These seeds are often infected by pests and diseases leading to bad germination and yield loss. The crop requires stakes to grow on which need to be taken from the remaining forests. Finally, post-harvest losses can be important due to inappropriate storage conditions.

In addition, yam production in West Africa is also affected by taboos. For instance, some people believe that women should no enter in yam fields at the risk of decreasing the production and women except widows should not own yam fields. Local knowledge is not always appropriate. Some farmers cannot recognise the white powdery mealybugs on yam tuber, a pest transferring diseases that spreads from plant to plant. They rather think that this shows the presence of potash, concluding that potash is dangerous for the plant.

Improving traditional yam cropping practices in West Africa requires an approach that includes stakeholders in the entire research process. To do so, YAMSYS developed innovation platforms, where stakeholders (yam producers, traders, transporters, researchers, extension agents, microfinance institutions, political, administrative, traditional and religious authorities and the media) sit down and discuss together the problems of actual yam systems and how they can be solved.

YAMSYS approach

YAMSYS has deployed its activities since 2015 on four sites, located along a gradient ranging from the humid forest to the northern Guinean Savannah. Researchers started with a characterisation of the ecological and socio-economic diversity of yam systems at each site. The key stakeholders were identified to form innovation platforms at each site. These platforms met to identify and rank the bottlenecks to yam production. Options that could fix those bottlenecks were jointly developed and started to be tested in researchers'-managed trials. The results of these trials were discussed within the platforms. Farmers selected options and started to test them in their fields. Once proven efficient and acceptable by farmers, these options will be communicated to agricultural extension institutions for upscaling.

Preliminary results

The platforms prioritised actions on "clean seed", fertilisation, planting density, optimised staking techniques, crop rotation and storage. "Clean seeds" are small tuber parts, treated with a cocktail of fungicides and ashes, allowing for optimal germination. In the researchers'-managed trials, we reached tuber yields up to 20 t ha^{-1} for *D. rotundata* in Côte d'Ivoire and only 12 t ha^{-1} in Burkina Faso. We reached tuber yields up to 35 t ha^{-1} for *D. alata* in Côte d'Ivoire and only 5 t ha^{-1} in Burkina Faso. In Burkina Faso low yields were due to difficult soil and climate conditions. The high yields were due to the use of "clean seeds" of improved varieties and nutrient inputs and to the regular plantation density.

In the farmers'-managed fields, farmers multiplied their tuber yields up to two times with the options proposed by the platforms. Socio-economic research is now undertaken to analyse the profitability and the adoption potential of these options. The long-term effects of the options on soil properties also need to be clarified. Training and communication materials for the dissemination of the options are being prepared and will be transferred to agricultural extension agencies. Upscaling has begun since an Ivorian institution already requested YAMSYS to develop innovation platforms on yam and to test the developed options in other yam growing areas of the country.

Lessons learnt

It was essential to fully include the stakeholders in the research process, otherwise any attempt to promote best practices would have been doomed to failure. Involving sceptic farmers was important, as once they were convinced, they became the best possible project ambassadors. Including stakeholders not directly concerned by yam, such as security forces, the microfinance sector and the media was equally important, as they facilitated the implementation and the acceptance of the project. The capacity building of farmers, extension agents and students and communication efforts were all indispensable.

Researchers needed patience, as stakeholders needed time to accept new things, which were sometimes contrary to their own local knowledge. The communication with agricultural extension agencies and national policy-making bodies needs now to be further developed. Finally, we believe that the approach developed by YAMSYS could be applied to other production systems, for much improved agricultural productivity in West Africa.

Swiss Programme for Research on Global Issues for Development

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How Bayesian Networks are pioneering the 'smart data' revolution

Norman Fenton and Martin Neil ask what next after 'big data', focussing on how Bayesian Networks are pioneering the 'smart data' revolution

The era of 'big data' offers enormous opportunities for societal improvements. There is an expectation – and even excitement – that, by simply applying sophisticated machine learning algorithms to 'big data' sets, we may automatically find solutions to problems that were previously either unsolvable or would incur prohibitive economic costs.

Yet, the clever algorithms needed to process big data cannot (and will never) solve most of the critical risk analysis problems that we face. Big data, even when carefully collected is typically unstructured and noisy; even the 'biggest data' typically lack crucial, often hidden, information about key causal or explanatory variables that generate or influence the data we observe. For example, the world's leading economists failed to predict the 2008–2010 international financial crisis because they relied on models based on historical statistical data that could not adapt to new circumstances, even when those circumstances were foreseeable by contrarian experts. In short, analysts often depend on models that are inadequate representations of reality – good for predicting the past but poor at predicting the future.

These fundamental problems are especially acute where we must assess and manage risk in areas where there is little or no direct historical data to draw upon; where relevant data are difficult to identify or are novel; or causal mechanisms or human intentions remain hidden. Such risks include terrorist attacks, ecological disasters and failures of novel systems and marketplaces. Here, the tendency has been to rely on the intuition of 'experts' for decision-making. However, there is an effective and proven alternative: the smart data approach that combines expert judgment (including an understanding of underlying causal mechanisms) with relevant data. In particular, Bayesian Networks (BNs) provide workable models for combining human and artificial sources of intelligence even when big data approaches to risk assessment are not possible

BNs describe networks of causes and effects, using a graphical framework that provides rigorous quantification of risks and clear communication of results. Quantitative probability assignments accompany the graphical specification of a BN and can be derived from historical data or expert judgment. A BN then serves as a basis for answering probabilistic queries given knowledge about the world. Computations are based on a theorem by the Reverend Thomas Bayes dating back to 1763 and, to date, provides the only rational and consistent way to update a belief in some uncertain event (such as a decline in share price) when we observe new evidence related to that event (such as better than expected earnings).

The problem of correctly updating beliefs in the light of new evidence is central to all disciplines that involve any form of reasoning (law, medicine and engineering as well as finance and indeed AI). Thus, a BN provides a

general approach to reasoning, with explainable models of reality, in contrast to big data approaches, where the emphasis is on prediction, rather than explanation and on association rather than causal connection.

BNs are now widely recognised as a powerful technology for handling risk, uncertainty and decision making. Since 1995, researchers have incorporated BN techniques into software products, which in turn have helped develop decision support systems in many scientific and industrial applications, including: medical diagnostics, operational and financial risk, cybersecurity, safety and quality assessment, sports prediction, the law, forensics and equipment fault diagnosis.

A major challenge of reasoning causally is that people lacked the methods and tools to do so productively and effectively. Fortunately, there has been a quiet revolution in both areas. Work by Pearl (Turing award winner for AI), has provided the necessary philosophical and practical instruction on how to elicit, articulate and manipulate causal models. Likewise, our work on causal idioms and influence diagrams has been applied in many application areas to make model building and validation faster, more accurate and ultimately more productive.

Also, there are now software products, containing sophisticated algorithms, that help us to easily design the BN models needed to represent complex problems and present insightful results to decision makers. Compared to previous generations of software these are more powerful and easier to use – so much so that they are becoming as familiar and accessible as spreadsheets became in the 1980s. Indeed, this big leap forward is helping decision makers think both graphically, about relationships and numerically, about the strength of these relationships, when modelling complex problems, in a way impossible to do previously.

Recent research has now made it easy to accurately incorporate numeric variables in the analysis, an obvious practical requirement, but one that the past generation of BN algorithms could not satisfy. There are now BN products that implement the latest and most accurate inference algorithms, as well as:

- Provide 'smart' learning of relationships from data – with or without missing values – incorporating as much or as little expert judgement as required.
- Automatically identify and select a decision strategy to maximise overall utility or minimise overall risk, using hybrid influence diagrams.
- Compute the 'value of Information' of uncertain variables in terms of how much should be paid to find more information out about them.

Our recent and ongoing research projects are providing ever more efficient algorithms both for building and deploying BNs (such as in patient-held medical devices and energy smart meters), including efficient cloud-based services for applications like cybersecurity risk analysis.

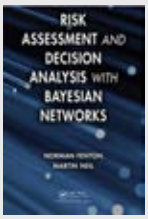
Many are asking what comes after 'big data'? Surprisingly, the ideas of Thomas Bayes, despite being pioneered over 250 years ago, may provide the answer in the form of smarter decisions from data and causal, uncertain knowledge.

Our projects

Much of the recent and ongoing BN research described here is from projects:
www.bayes-knowledge.com
www.pambayesian.org
www.causaldynamics.org

Software

Much of the new BN functionality described here has been incorporated into version 10 of the AgenaRisk software (www.agenarisk.com)



Book

"Risk Assessment and Decision Analysis with Bayesian Networks" 2012, CRC Press by Fenton and Neil provides a thorough overview of BNs that is accessible to non-mathematical readers. Second edition available August 2018 (see https://www.crcpress.com/9781138035119)

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Health, prevention and long-term care in Germany

The background of Jens Spahn, Germany's Federal Minister of Health is examined here, plus the wider work of the Federal Ministry of Health concerning health, prevention and long-term care

Since 2018, Jens Spahn has been the Federal Minister of Health, in Germany. Before looking at some of the Ministry's current priorities, it's helpful to find out something about his background. Indeed, after training as a banker, he was Germany's Parliamentary State Secretary to the Federal Minister of Finance between 2013. Since 2002, he has been a Member of the German Bundestag.[1]

Federal President Frank-Walter Steinmeier appointed Jens Spahn as the Federal Minister of Health in the Cabinet of Federal Chancellor Angela Merkel on Wednesday 14th March 2018. In terms of his credentials for this very important role, there is no doubt that the 37-year-old Spahn has these in abundance. For example, from 2005 to 2015 he was a first spokesperson of the CDU/CSU Parliamentary Group in the Bundestag's Committee on Health – at the time he was, in fact, the group's health spokesperson.

Spahn has certainly gathered much experience in government during his time as the Parliamentary State Secretary to the Federal Minister of Finance between July 2015 and March 2018. Spahn was born in Ahaus in the Münsterland region of Germany and later, he commenced his professional career as a bank business management assistant and after that, he studied political science.

The Federal Ministry of Health's wider work

In terms of the Federal Ministry of Health's wider work, it is worth pointing out that they are responsible for many policy areas, which can be summed up in by the areas of health, prevention and long-term care. Indeed, at the heart of the area, 'health' is the vital task of safeguarding and further developing the effectiveness of statutory health insurance. In this vein, the Ministry conducted a major healthcare reform in 2007, something that improved the quality and efficiency of the healthcare system and strengthened patients' interests, as well as contributing to the stabilisation of contribution rates.

"Spahn has certainly gathered much experience in government during his time as the Parliamentary State Secretary to the Federal Minister of Finance between July 2015 and March 2018. Spahn was born in Ahaus in the Münsterland region of Germany and later, he commenced his professional career as a bank business management assistant and after that, he studied political science."

When it comes to prevention, this is becoming ever-more important in Germany today. Indeed, the Ministry of Health conducts successful campaigns and initiatives in areas such as the action plan to implement the HIV/AIDS control strategy, '3,000 Steps' (a campaign against a lack of exercise) and initiatives concerning women's and children's health, for example.

In addition, the reform of long-term care in 2008 resulted in tangible improvements for people in need of long-term care, as well as their relatives and nursing staff. For the very first time, patients had a legal claim to individual long-term care counselling (case management) and added to that, a series of measures helped to eliminate any quality shortcomings in nursing facilities.[2]

One important area of German health policy is vaccinations, which are among the most important and effective means of preventing disease in the medical world. One aspect of this is that there has been a marked increase in immunisation uptake in Germany, for example, paediatric immunisation rates are said to have been steady during the last decade. However, gaps still remain in childhood vaccinations against

Image: © Bildquelle: BMG/Jochen Zick

Jens Spahn, Germany's Federal Minister of Health

hepatitis B, pertussis and the second dose of measles vaccine, rubella and mumps. Added to this, adolescents and adults, too, have inadequate vaccination protection, for example, vaccination coverage rates for measles still fall short of those recommended by the World Health Organization.[3]

Another interesting area of the Ministry's work concerns antibiotic resistance which was one of the topics on the agenda of the German G20 Presidency in 2017. One of the key objectives of that was the promotion of the 'One Health' approach and the strengthening of incentive mechanisms for the research and development of new antibiotics. At a joint event in Berlin during the September of that year, representatives of the public health institutes within the human and veterinary medicine sector of the G20 discussed ideas on the joint goal of tackling antibiotic resistance.

Finally, it's worth highlighting that the Federal Ministry of Health's website is a mine of very useful information, should you want to learn more about Germany's health policy, whether that be practical advice to protect against diseases and infections or who does what in the German health system when it comes to doctors, hospitals, pharmacies, for example.[4] ■

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Sources of funding in the development of therapies for Huntington's disease

Leora Fox, Jennifer Simpson and George Yohrling from the Huntington's Disease Society of America explore the sources of funding in the development of therapies for Huntington's disease (HD)

Huntington's Disease (HD) is an inherited brain disorder affecting approximately 1 in 10,000 people in the United States.[1,2] HD patients suffer from a triad of debilitating cognitive, emotional and movement symptoms that usually strike during a person's prime working years but can sometimes appear as young as early childhood. Huntington's disease is defined as a rare disorder because of its prevalence of fewer than 200,000 affected individuals in the United States.[3] An estimated 30,000 people in the US are symptomatic, with an additional 200,000 at risk.[4,5] In comparison, 5.7 million Americans are affected by Alzheimer's disease and 14 million are projected to be diagnosed by 2050.[6] Given this disparity in medical and social impact, the development of treatments for rare and debilitating disorders like HD requires the collective efforts of public and private entities.

The management of Huntington's disease relies on conventional, non-specific medications to address individual psychiatric symptoms like anxiety and psychosis and to calm the characteristic involuntary movements known as chorea. These approaches can temporarily mask the signs of a deteriorating brain, but they are not reparative or restorative. Designing therapies aimed at the genetic and biological causes of HD requires an in-depth understanding of its underlying biology and pathology. Traditionally, such research has been the realm of government entities like the National Science Foundation (NSF) and the National Institutes of Health (NIH). As the largest public funder of biomedical research worldwide,[7] the NIH dedicated more than $2 billion to neurodegenerative disease research in 2016, with $37 million devoted to HD-specific projects, comprising just under 2% of the spending on neurological diseases.[8] Funding of studies that look at the biology and pathology of rare neurodegenerative diseases like HD are essential to furthering our understanding of rare and complex diseases, paving the way for novel therapies in humans.

Limited funding in the HD field leaves little space for high-risk, high-reward projects and creates intense competition that can discourage a young scientist's commitment to a rare disease like HD. As a result, research funding through private entities like non-profit foundations must be present to foster medical progress. The HD field is extremely fortunate to have dedicated sources of non-government funding; the largest, CHDI Foundation, a privately-funded, not-for-profit biomedical research foundation, is focused solely on the development of therapeutics for Huntington's disease. CHDI has an estimated annual budget of $100 million,[9] nearly three times the reported NIH contribution to HD research in 2016. To avoid duplicate efforts and maintain collaborative relationships, other HD organisations carve out complementary niches in their research focus or grant funding programmes. The Huntington's Disease Society of America, for example, funds HD research initiatives that focus on human-centric projects, engaging promising young scientists, promoting opportunities for community engagement in trials and providing support to researchers with strong mentorship who are committed to becoming independent and devoting their professional lives to HD.

Ultimately the goal of government and non-profit investments in HD research is to bring effective treatments to market. This is greatly expedited by public-private partnerships and requires investment from industry, especially as novel potential therapies enter the clinical phases of the research pipeline. In the HD field, the efforts of researchers supported by the government, the not-for-profit sector and industry funding, combined with the tenacity and dedication of

affected families, culminated recently in a clinical trial to test the safety of a novel gene therapy designed with the underlying biology of HD in mind. Its success, announced in December 2017 and detailed at the 2018 CHDI HD Therapeutics Conference, has led to a significant investment from Roche Pharmaceuticals to plan and execute a critical Phase 3 trial.[10] Beyond supporting and contributing to the medical research itself, public-private partnerships help to speed the regulatory processes behind drug development and approval. In March 2018, the Critical Path Institute (C-Path) and CHDI announced the official launch of the Huntington's Disease Regulatory Science Consortium (HD-RSC), which will include representatives from various sectors and will focus on cost reduction and efficiency in HD drug development.[11]

With the field poised on the brink of several promising trials, diverse funding sources and collaborative initiatives between government, the not-for-profit sector and industry remain critical to expand our knowledge of HD biology and hasten the progress of medicine. The rarity of Huntington's disease does not lessen the needs of affected families, and additional resources serve to solidify a collaborative research community and power faster medical innovations both inside and outside of the HD field. Therefore, we need to be vigilant in ensuring increased access to funding for rare disease projects. This includes working to increase the visibility of rare disease research in such a way that both public and private entities recognise the potential of their investments to inform broader medical applications, pave the way for novel methodologies, and shape policy for the Huntington's disease community and beyond. ■

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What's in an aggregate? Therapeutic intervention in Huntington's

Naoko Tanese from New York University School of Medicine outlines their work around Huntington's disease (HD) and effective new targets for therapeutic intervention

Huntington's disease (HD) is a rare hereditary neurodegenerative disease that strikes patients in mid-life. American physician George Huntington first described the disease in 1872 after seeing affected residents in East Hampton, New York. Patients generally experience a progressive decline in cognitive, psychiatric, and motor functions. The disease is fatal. In 1993 an international team of scientists discovered the gene that causes the disease. Despite years of intense research, no cures or treatments to delay the onset or prevent the progression of the disease are available.

Naoko Tanese, PhD, Associate Dean for Biomedical Sciences, and Director, Sackler Institute of Graduate Biomedical Sciences

HD is caused by an inherited dominant mutation in the Huntingtin gene, HTT. This means an offspring of a parent who carries a mutant HTT gene has a 50% chance of inheriting the mutant gene. The mutation results in an increased number of repeats (greater than 40) of the amino acid glutamine in the encoded Huntingtin protein (HTT).

A normal HTT protein has between 7 and 35 glutamines. Increased number of glutamine repeats changes the property of the protein and renders it toxic to cells. The HTT protein is present throughout the body and throughout life. However, mutant HTT is toxic to select cells. Postmortem examination of the brains of affected individuals shows massive cell loss in certain parts of the brain, leaving other cells and tissues intact. This indicates that some neurons are particularly sensitive to the toxic effects of mutant HTT.

The normal HTT protein has been implicated in many cellular functions. However, we have an incomplete understanding of how mutant HTT causes the disease. A better understanding of the functions of the normal and mutant HTT protein is paramount, if effective therapies or cures are to be developed.

Proteins made in cells maintain certain structures dictated by their biochemical and biophysical properties. This is referred to as protein folding. When proteins misfold, they often lose their normal functions. Cells have developed elaborate mechanisms to remove such aberrant, misfolded proteins. This protects the cells from potential harmful effects of misfolded proteins.

However, misfolded proteins can accumulate over time and form irreversible aggregates that impair cellular homeostasis. These aggregates are a hallmark of many neurodegenerative diseases. They are found in postmortem brain tissues of affected individuals. Age-associated diseases such as Alzheimer's disease, are linked to protein misfolding. HD is

also considered a protein misfolding disease although many other mechanisms are thought to play a role in the disease pathogenesis.

Decades of research have uncovered intriguing properties of different types of protein aggregates, some of which are RNA-protein granules found in normal cells. Each granule appears to have distinct properties and its formation is driven by specific sets of proteins and RNA. Some granules are formed in response to stress. This mechanism serves to halt energy-consuming cellular activities, by sequestering proteins involved in key biochemical processes. Upon removal of the stress, granules disassemble and the released proteins resume their normal functions.

Interestingly, mutant proteins linked to several neurodegenerative diseases have been located within these types of granules. They include mutant RNA binding proteins associated with amyotrophic lateral sclerosis, spinal muscular atrophy, and fragile X syndrome. These RNA binding proteins normally play a role in RNA transport, translation of RNA to make proteins, and formation of RNA-protein complexes.

Mutant RNA binding proteins, however, show altered biophysical properties. They have increased propensity to interact with one another and affect the formation and function of granules. There is increasing evidence that over time mutant RNA binding proteins in these granules steadily accumulate and become converted to irreversible aggregates that are toxic to cells. Neurons are vulnerable to aberrant proteins that accumulate because neurons do not divide. Ultimately the machinery in the cell fails to remove toxic proteins, causing cell death.

Since the functions of normal HTT and the mechanisms by which its mutant counterpart contributes to HD remain unclear, my lab began investigating the role of HTT in RNA metabolism. New imaging techniques have helped us determine the location of the normal HTT protein inside neurons.

Strikingly, we discovered that HTT could be found near neuronal RNA granules. RNA granules are large RNA-protein assemblies responsible for transporting RNA to specific locations in the neuron. To determine whether HTT influences RNA localisation, we reduced the level of normal HTT in neurons grown in a culture dish and examined its effect on transport of RNA. We found that the reduction of HTT in cells disrupts RNA localisation. The result points to HTT contributing to the integrity of RNA granules during RNA transport.

New experiments in HTT

To further investigate cellular processes that HTT is involved in and how they might differ in mutant HTT, we designed experiments to purify normal and mutant HTT proteins from cells and tissues. We next identified proteins that interacted with each form of HTT. By identifying the functions of the proteins that co-purified with HTT, we uncovered new functions for HTT. Analysis of the binding partners of HTT proteins revealed that both normal and mutant HTT interact with proteins involved in RNA metabolism and protein synthesis.

We have thus uncovered new roles for normal and mutant HTT in RNA metabolism. The findings have several implications for the development of HD. We have located mutant HTT in neuronal granules, similar to those associated with aforementioned RNA binding proteins linked to neurodegenerative diseases. Our results suggest HTT has a role in the formation of RNA-protein granules.

Unlike normal HTT, mutant HTT has a propensity to interact with one another through the increased repeat sequence. At high concentrations, mutant HTT alters biophysical properties of RNA-protein assemblies and shifts the equilibrium in favour of forming aggregates.

Furthermore, a recent study reported stable formation of RNA aggregates containing repeat sequences. Collectively, the findings suggest that mutant HTT together with repeat sequence-containing RNA forms granules that become converted to irreversible toxic aggregates over time. The development of chemical agents that prevent aggregation or disrupt aggregates may serve to reverse the toxicity associated with the mutant protein and RNA. Through understanding of how HTT supports neurons with these functions, we hope to reveal effective new targets for therapeutic intervention.

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Turning health data into knowledge to improve lives

Amanda White, Director of Communications and Marketing at Health Data Research UK, reflects on the opportunities to harness the UK's strengths in data science to transform health

The UK has a rich heritage of using health data for research, innovation and to inform care. The expertise in collecting data on patients and populations, linked to careful computation and data analysis has led to scientific breakthroughs that have transformed lives over many decades; for example, Sir Richard Doll's ground-breaking discovery in 1950 of the association between smoking and cancer.

As we approach the fourth Industrial Revolution, we have the exciting prospect of analysing a unique array of health, biological, genomic and other multi-dimensional datasets across a population of up to 65 million people. Any such analyses have to be in the public interest in our quest to address health research challenges relevant to a growing and ageing society.

There is an extraordinary opportunity to combine these unique assets to transform lives at scale. We know from experience that insights gained through health data research can improve the quality of health and social care services, for example, improving cancer and heart disease outcomes and have positive implications for public health, our understanding of disease and the safe and effective use of medicines. In turn, this improves the way we are able to prevent, detect and diagnose diseases such as cancer, heart disease and asthma and allow patients to benefit from scientific breakthroughs much faster.

Scale and joining up expertise is important. In 2017, the Medical Research Council, the Economic and Social Research Council, the Engineering and Physical Sciences Research Council, the government health research departments in England, Scotland, Wales and Northern Ireland came together with charities including the Wellcome Trust and British Heart Foundation to create Health Data Research UK (HDR UK) – a new nationwide institute for the UK to make game-changing improvements in people's health. These nine funders recognised the pivotal contribution of health data research to the UK's ambition to be a leader in life sciences.

Health Data Research UK is harnessing the inter-disciplinary expertise and high-value data assets to power health data science discovery and innovation to improve human health. Working in partnership with universities, NHS organisations, charities, industry and other charitable institutions, it has made an initial investment of £67 million in six substantives sites; each with world-class expertise; and a track record in using health data securely to derive new knowledge and scientific discovery.

These HDR UK Sites will develop secure and controlled environments within the highest standards of data security, privacy and ethical approval, to provide expert research data services and enable the ethical analysis and sharing of healthcare, clinical, genomic, biological and other multi-dimensional data. Together they will perform ground-breaking research, with an initial focus on; (i) using data and analytics to inform quality health systems; (ii) the development of precision medicine so that we harness genetic information to make interventions more precise, personalised, participatory and preventative; (iii) making clinical trials more efficient and effective; and (iv) using technologies for public health interventions.

Our priority is to understand all research on data in a trustworthy, transparent and legal way, ensuring all analyses are in the public interest. From a technical perspective, data are kept separate, with ownership remaining with the host organisations (for example, the NHS) and are only linked when there is a legitimate purpose. Security and trust are achieved in layers, with

multiple approaches concurrently at work that reduce data travel, separate personal identifiable data from other data, restrict access to accredited researchers and use effective consent and anonymisation methods. Public engagement and participation that is informed and shapes the research programme are vital. Our research principles will build on best practice and we will work with patients and the public to ensure that data is used to serve the needs of society.

Previous studies in diabetes have shown that turning data into knowledge has improved co-ordination of clinical care, reduced life-threatening complications such as amputation and blindness, whilst shedding light on the genetic causes of disease. The vision of Health Data Research UK is to demonstrate impact across multiple disease areas and care pathways to support the health and quality of health services of the UK and beyond.

"As we approach the fourth Industrial Revolution, we have the exciting prospect of analysing a unique array of health, biological, genomic and other multi-dimensional datasets across a population of up to 65 million people. Any such analyses have to be in the public interest in our quest to address health research challenges relevant to a growing and ageing society."

What is informatics?

Informatics is the use of maths, statistics and computer science to get answers from large, complex datasets. Datasets in health and biomedical research come from lots of different sources. Health Data Research UK works with biological, genomic, clinical, social and environmental data. Researchers will also use emerging forms of data like that from wearable technology.

About Health Data Research UK

Health Data Research UK is the national Institute for data science in health. We are funded by the Medical Research Council, the British Heart Foundation, the National Institute for Health Research, the Economic and Social Research Council, the Engineering and Physical Sciences Research Council, Health and Care Research Wales, Health and Social Care Research and Development Division (Public Health Agency, Northern Ireland), Chief Scientist Office of the Scottish Government Health and Social Care Directorates and Wellcome.

The six HDR UK sites and their members are:

Cambridge – Wellcome Sanger Institute, European Bioinformatics Institute (EMBL-EBI), University of Cambridge.

London – UCL, Imperial College London, King's College London, Queen Mary University of London, The London School of Hygiene & Tropical Medicine.

Midlands – University of Birmingham, University of Leicester, University of Nottingham, University of Warwick, University Hospitals Birmingham NHS Foundation Trust.

Oxford – University of Oxford.

Scotland – University of Edinburgh, University of Aberdeen, University of Dundee, University of Glasgow, University of St Andrews, University of Strathclyde.

Wales/Northern Ireland – Swansea University, Queen's University Belfast. ■

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Medical and pharmaceutical statistics research: Professional development courses

Prof Thomas Jaki from the Medical and Pharmaceutical Statistics Research Unit at Lancaster University provides an overview of the professional development courses offered at the unit

The Medical and Pharmaceutical Statistics Research Unit was established directorship of Professor John Whitehead at The University of Reading in 1994. In 2007, the unit relocated to Lancaster University, where it is part of the Department of Mathematics and Statistics. The unit exists to develop and evaluate novel statistical methods of study design and data analysis relevant to pharmaceutical companies and medical research institutes.

The unit undertakes methodological research, often in direct collaboration with companies and provides professional development courses and a consultancy service. Our main areas of research are: pharmacological modelling, dose-escalation studies, Bayesian decision procedures, adaptive clinical trials and survival analysis.

Professional development courses

Commissioned courses: All the professional development courses may be commissioned by a company or organisation, tailored to meet your special requirements and presented at a location of your choice. Please contact us at mps@lancaster.ac.uk to discuss your specific requirements or for further information.

Scheduled courses: A selection of professional development courses are scheduled each year for presentation at Lancaster University, some of which also constitute part of our MSc in Statistics.

Scheduled courses at Lancaster University

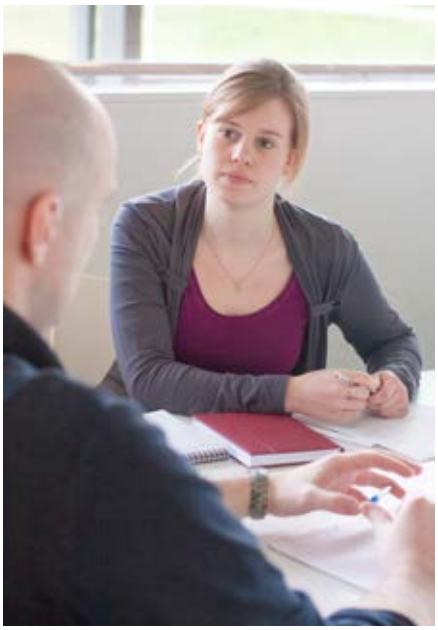
Data and Safety Monitoring Boards (half a day)

Data and Safety Monitoring Boards (DSMBs) are a common feature of long-term clinical studies in serious and life-threatening conditions. This workshop describes the remit and composition of DSMBs and how their work relates to other parties involved in the study, such as the sponsor, the study project team.

Consideration is given to the nature and purpose of safety and efficacy data reports presented to the DSMB and the balance between the timeliness and accuracy of the data available is discussed. Statistical problems inherent in repeatedly making multiple treatment comparisons are highlighted and formal stopping guidelines based on repeated safety analyses are presented.

Pharmacological Modelling (three days)

Pharmacological models are used to describe the pharmacokinetics (PK) and pharmacodynamics of drug administration. The former concerns how the drug becomes distributed within the body and the latter how drug concentrations are related to physiological effects. The way in which models are derived from simplified



representations of the body and approaches to the estimation of model parameters will be described. More advanced hierarchical models and Bayesian methods for population pharmacokinetics will be discussed.

Practicals will provide an opportunity for participants to fit simple models to data and to design and evaluate phase I dose-escalation studies.

Survival and Event History Analysis (three days)

In many medical applications, interests lie in times to or between events. Examples include the time from diagnosis of cancer to death or times between epileptic seizures. This course begins with a review of the standard approaches to the analysis of censored survival data. Survival models and estimation procedures are reviewed, and

the emphasis is placed on the underlying assumptions, how these might be evaluated through diagnostic methods and how robust the primary conclusions might be to their violation. The study design is considered, in particular how to define events and censoring and how to determine a suitable sample size and duration of follow-up. Each lecture is complemented by a practical session implementing the methods using R.

Adaptive Methods in Clinical Research (three days)

The development of a new treatment in therapeutic areas such as cardiovascular disease, cancer or stroke are complex undertakings. There is a great interest from the pharmaceutical industry in the possibility that clinical trials can be designed with adaptive features that have the potential to save development costs and to shorten the time-to-market of a new treatment. These adaptive features include selecting the most promising treatments among several alternative ones, stopping a trial early for either efficacy and/or futility and sample size changes.

This course will introduce different adaptive methods and critically evaluate them. Practical sessions and discussion groups are looking at the implementation of these methods to supplement traditional lectures.

Designing Phase I Dose-Escalation Trials (two days)

The importance of exploratory clinical research prior to the launch of a large-scale definitive phase III clinical trial is becoming increasingly recognised. Dose-escalation studies are the first-in-human studies which aim to determine a safe dose or range of doses which can be taken forward for further development. Advances in the identification of medical biomarkers of therapeutic effect and in statistical techniques, based on adaptive designs and Bayesian inference, now allow such studies to be designed efficiently, to consider the information from a variety of sources and to combine various objectives, such as establishing safety and seeking evidence of a potential benefit.

This course presents a state-of-the-art methodology for dose-escalation studies. The course will be delivered through a mixture of lectures, practical sessions and discussion sessions.

"There is a great interest from the pharmaceutical industry in the possibility that clinical trials can be designed with adaptive features that have the potential to save development costs and to shorten the time-to-market of a new treatment."

Other courses available for commission

- Sample Size Determination in Clinical Trials (one to two days);
- Bayesian Methods for Clinical Trials (one to three days);
- Designing Early Phase Clinical Trials (one to three days) and;
- Adaptive methods for non-statisticians (one day).

To find out more contact us at mps@lancaster.ac.uk or visit mps-research.com .

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The importance of research into aplastic anaemia (AA)

Grazina Berry from Aplastic Anaemia Trust explains why research into aplastic anaemia (AA) is so important

The Aplastic Anaemia Trust (AAT) launched its new research strategy in April 2018 inviting prospective applicants to come forward with proposals for truly translational research into aplastic anaemia (AA) and allied rare bone marrow failures. By opening up the gate for research proposals, we're hoping to get closer to the eradication of this rare yet devastating disease.

Why is research into a rare bone marrow failure, such as aplastic anaemia, so important? It's vital for two key reasons:

1. Research will enable a better understanding of what fails in our immune system thus causing it to attack the bone marrow and destroy the vital stem cells.

2. Genetic analysis will enable the identification of faulty genes that may cause aplastic anaemia in later life. This will lead to better treatments, including preventive ones.

In recent years, the AAT has funded ground-breaking clinical research into acquired aplastic anaemia at King's College Hospital, enabling to predict responses to treatment, published in Blood 2016.

We have provided funds for a clinical nurse specialist at King's, to coordinate vital care and enable patients to participate in clinical trials with nearly 400 patients supported.

We funded the establishment of aplastic anaemia and bone marrow failures registry, enabling the study of epidemiology and planning services for the future. Nearly 500 patients have been recruited, with different types of bone marrow failure, of whom 43% have acquired aplastic anaemia and with 110 people diagnosed with either severe or very severe aplastic anaemia. A break-through finding emerged of higher than the expected incidence of inherited aplastic anaemia. This study has enabled a joined project with the National Institute of Health (NIH), USA, to produce the largest study of inherited heterozygous RTEL1 mutations in patients with aplastic anaemia and myelo-dysplastic syndrome (MDS), published in Blood Advances, in 2017. We were the first to show an association between acquired somatic mutations in aplastic anaemia and risk of later developing MDS – reported in the Blood Journal, 2014.

> "Today, more than ever, we are committed to enabling research in the areas that will lead to improved treatments for all patients affected, a better understanding of aplastic anaemia and allied rare bone marrow failures, and ultimately finding a cure."

Thanks in large part to the effort of the AAT, survival rates have vastly improved and currently stand at around 80%. We recognise that more remains to be done to ensure that everyone affected, whether adult or child, survives the effects of the devastating disease and can lead healthy and fulfilling lives.

Today, more than ever, we are committed to enabling research in the areas that will lead to improved treatments for all patients affected, a better understanding of aplastic anaemia and allied rare bone marrow failures, and ultimately finding a cure. ■

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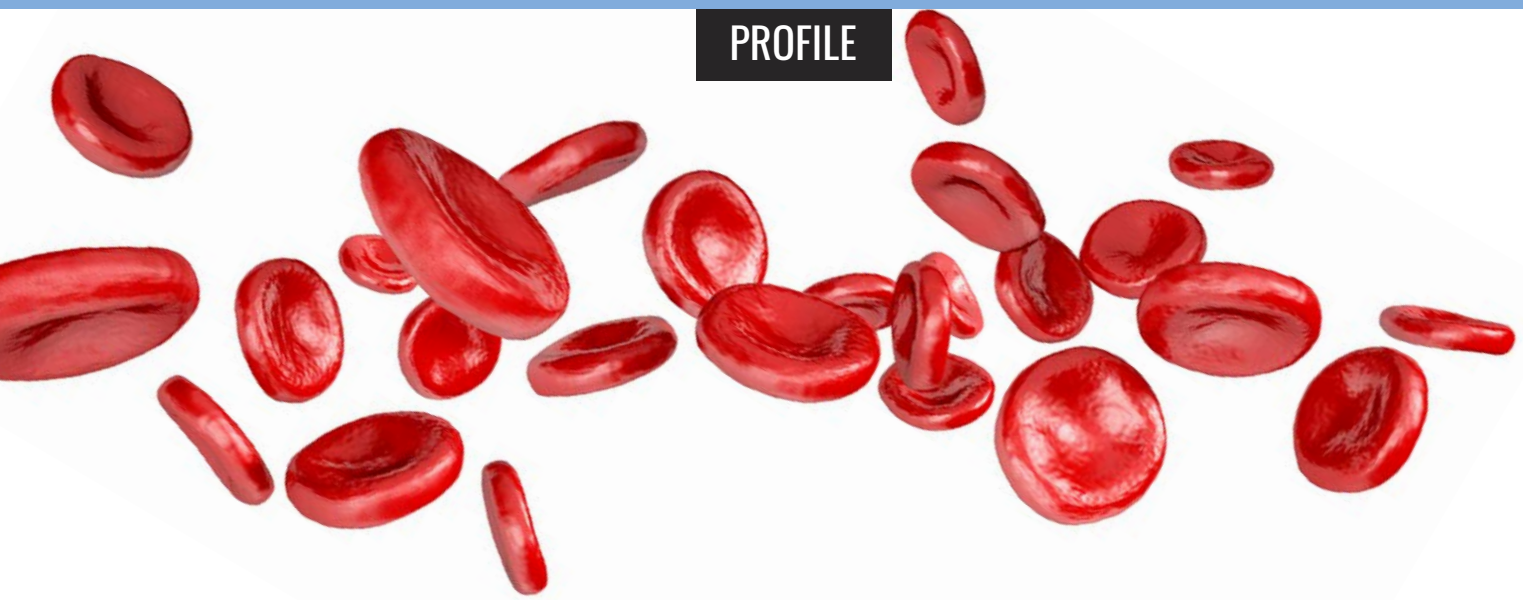

“Erythropoiesis in and out of the body”

Members of the RELEVANCE consortium – Anna Bogdanova, Francesca Aglialoro, Marieke von Lindern, Emile van Akker, Ashley Toye, and Pedro Moura – explain their thoughts on erythropoiesis, in and out of the body

Blood is literally the life, in terms of carrying the life-giving supply of oxygen the body needs. The average healthy human must produce over 2 million new red blood cells (RBC) per second to replace an equal number of old RBC that are continuously removed. For some individuals with anaemia or with sickle cell disease, for example, the production of RBC in the body is not enough or defective. Here the common treatment is the transfusion of healthy donor RBC to these patients. Although donor blood transfusion product is a safe product, some transfused patients, especially those with chronic transfusions, can develop an immune response against the transfused blood. This phenomenon, termed alloimmunization, results in the destruction of the transfused cells. This occurs because of the blood groups present on the RBC surface. There are currently 40 blood group systems described and these vary between individuals and according to ethnicity. This poses a significant challenge for sourcing blood for some patients, such as the ethnically different sickle cell disease and thalassemia patients, whose blood may not match the largely Caucasian donor base of many European National blood services. Blood services are working to address this problem, by increasing donors from these groups or donation frequency of certain rare donors with the most compatible blood. They are also working to improve the preservation of blood to allow it to be stored for longer and are developing ways to manufacture blood from stem cells or immortalised cells, such as induced pluripotent cells or cell lines.

The current blood pre servation and storage is not optimal, reducing RBC lifespan in the body. Around 25% of stored red cells may be cleared straightaway, within 24 hours after transfusion of a normal donation. Consequently, some patients who undergo regular transfusions risk an iron overload, which can cause life-threatening liver, heart and joint problems. Thus, the improvement of RBC storage conditions and/or pre-treatment of the stored cells to return to their original state in regards of deformability, ion content and metabolic/redox balance are being addressed by members of the RELEVANCE ITN consortium, such as researchers from Sanquin Blood supply.

RBC production is the final result of erythropoiesis, a complex process with many underlying molecular mechanisms. The role of hormones in RBC production was first described by Carnot and Deflandre in 1906 and substantial progress has been achieved since then in understanding the molecular processes that drive erythropoiesis. For instance, one key growth factor for producing RBC is erythropoietin. This hormone is released naturally by the kidney and allows more RBCs to be made at high altitudes. An increase of this hormone’s levels in the body then leads to an up to 10-fold increased RBC production, which results in an increased oxygen-carrying capacity. The end result of this adaptation is a that the body is able to compensate for the low-oxygen (hypoxic) environment, eventually functioning as well as in its usual environment. The stability of these

new RBCs is another aspect that the RELEVANCE consortium is studying.

RBCs can also be produced in the laboratory using cell culture media containing erythropoietin and several other growth factors, but currently, only small amounts (enough for a baby) have been produced. The ultimate goal is the mass production of RBCs to numbers comparable with those created in the body. To do so efficiently may require re-creation of the conditions found in the bone marrow. If this goal is achieved, we may be able to combat blood disorders in which RBCs are not produced in enough quantity or are destroyed shortly after production (for example, sickle cell disease or beta thalassemia).

Working on this problem are researchers in Bristol, which includes the early stage researcher (ESR) Pedro Moura in Ash Toye's group, ESR Francesca Aglialoro within the group headed by Marieke von Lindern and Emile van den Akker from Sanquin-Amsterdam. These two groups aim to produce RBC with the ultimate goal of providing precision therapy for patients with rare blood groups and both groups closely collaborate within the framework of RELEVANCE. For example, the groups have recently reported a model system that produces macrophages, similar to those found in bone marrow to allow the study of how these specialised immune cells drive erythropoiesis more efficiently[1].

Although cultured red cells can be produced in the laboratory from donor stem cells, cell expansion needs to be improved and as such, we need to understand how these cells turn into the recognisable mature RBCs that our body produces. The Bristol and Sanquin groups are working on this. For example, Sanquin is defining conditions optimal for the expansion and transformation of precursor cells to red cells, the development of standard protocols and assessment of the properties of the resulting erythroid progenitor cells that finally turn into RBCs. In Bristol, they are studying the role of shear stress, which the cells experience in the circulation, on the maturation of the cells (Moura et al Manuscript submitted). Both research groups are also testing and optimising bioreactors to facilitate the scale-up of blood production.

Interestingly, as well as undertaking the work in RELEVANCE using human stem cells, these groups are working on next-generation sources of blood which could provide the key to a more plentiful supply. The Sanquin team is using human induced pluripotent stem cell lines (iPSCs) to potentially provide a sustainable supply of stem cells. The beauty of such an approach is that the resulting cells are identical, allowing for a high degree of standardisation and reproducibility[2]. The Bristol team is using the immortalised adult erythroid line from bone marrow cells, generated by Jan Frayne and David Anstee's groups called Bristol Erythroid Line Adult (BEL-A)[3]. Unlike the hematopoietic stem cells that can be isolated from adult blood, these cells have a potentially unlimited expansion capacity, whilst maintaining their ability to enucleate. Excitingly, CRISPR-Cas9 mediated gene editing was used by both groups to modify the immortal cells and enhance the compatibility of the generated cells by removing multiple blood group from the cell surface, paving the way for a customisable product[4].

The future is exciting for the research within the RELEVANCE consortium and we have given only a small taster here. This EU funded RELEVANCE network will provide new knowledge on the RBC life cycle, alteration in diseases and also adaption during exercise and altitude, to name but a few. It will contribute to further developments in producing RBCs, including scaling up the production and improving cell culture conditions which aim to take these cells to the clinic.

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NHS England: Digital transformation in the NHS

NHS England's views on digital transformation in the NHS are assessed here by Open Access Government

The size, complexity and scope of NHS services make digital transformation a unique challenge – could a dedicated standard help? The NHS is the fifth largest employer in the world, deals with over 1million patients every 36 hours and has an annual budget of over £126.2 billion, according to the NHS Confederation.

But it is not a single, monolithic body. In fact, around 9,000 different organisations are involved in commissioning or providing healthcare services, including 207 clinical commissioning groups, 135 acute non-specialist trusts, 54 mental health trusts and 7,454 GP practices.

By comparison, there are just 497 non-departmental public bodies that make up the UK's central government. Delivering digital transformation across such a large, federated and diverse organisation presents a unique challenge.

But, with almost nine out of 10 adults in the UK using the internet, there is an expectation from the public that they can access health information and services online as they would many other everyday activities, such as shopping, banking or paying their bills.

NHS Choices was launched in 2007 as the "front door" to digital services for NHS England, providing health information through articles, videos and tools to help the public make the best choices about health and lifestyle while easing pressure on health and social services by reducing unnecessary visits. The website currently receives around 48 million visits a month, accounting for a quarter of all health-related web traffic.

However, Dan Sheldon, Digital Strategy Lead for the Department of Health, wrote in a 2015 blog that there was much more to do. For example, with over 3,000 sites on the NHS.UK domain, on top of NHS Choices, information was often fragmented or not shared. Some basic services, such as registering with a GP, were not available online.

In the past three years, much progress has been made. A beta page has been launched to provide A-Z information on medicines and a community of designers has been built with half supporting services for patients, families and carers and the other half working for commissioners, clinicians, developers and other stakeholders in the health and social care system.

NHS Digital is now working on developing a dedicated standard, beyond the Government Digital Service standard, for digital services across the health service. The standard aims to improve efficiency and consistency for the thousands of bodies delivering digital content for the NHS by providing things like design essentials (such as shared fonts and colours, and reusable patterns) and better sharing of user research, while still allowing teams the flexibility to be creative.

A week-long "design sprint", as pioneered by Google Ventures, was held to consolidate knowledge, generate ideas and develop prototypes for testing with users.

Looking ahead, we know that a standard is set to be issued shortly for NHS Digital teams to start using – and evolving – while work continues on a product assessment process for digital services. NHS Digital is also inviting contributions to the development of the standard, particularly from those working in the NHS. ■

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Ethical Healthcare asks: Is the market ready for a novel approach to consulting?

Here, Ethical Healthcare Consulting explains how they look to shake up existing consulting models with a unique blend of quality combined with not-for-profit status

Ethical Healthcare Consulting (EHC) was set up after the founders saw how the NHS was paying so much in fees for quite often very little return – not in every case of course, but all too often. Simply put, the ultimate and overarching objective of any private enterprise is to deliver profits for shareholders which means prioritising profit over patient care, frequently compromising on quality to protect profit margins.

EHC hopes to change this and shake things up a little. The solution was to create a not for profit community interest company with a primary focus on supporting NHS staff and patients, whilst offering the same expertise to compete with the big consultancies. In essence, doing the right thing really well without a financial agenda. EHC is the only not-for-profit health informatics consultancy in the UK with one goal in mind, to do the best for patients and healthcare providers whilst offering unrivalled value for money.

Ethical Healthcare values

EHC believes that true partnership with the NHS can only be achieved through trust and alignment of values; a consultancy that places patients over profit, aligned with the values of the NHS. With no focus on profit margins, values are at the core of EHC's behaviours, engagement and the improvements and changes delivered to the NHS.

How Ethical Healthcare works

EHC would rather do a small number of things really well than dilute expertise across a wide range of services and use contractors that are not bought into the organisation's values.

> "EHC services focus on developing and leading programmes that will actually be delivered and sustained and that will make a difference."

With this in mind, the team has been created with like-minded experts in their field. There is no competitor that can provide more expertise and a better service at a lower cost. EHC also spends considerable time transferring knowledge to staff within partner organisations so that they continue to maintain and grow once the expertise leaves. Additionally, an integral part of EHC's core offerings is cultural baselining, ensuring staff have the tools, capability and core culture to be successful. It's a holistic approach.

Ethical Healthcare services

EHC services focus on developing and leading programmes that will actually be delivered and sustained and that will make a difference. Purely technical transformation is a waste of time if people don't understand the 'why' behind it. EHC's approach is one of inclusiveness and co-production. Staff must feel that they own transformation initiatives, but also be provided with the right strategic framework in which to deliver lasting change.

Whether it's enterprise imaging or a replacement EPR system, EHC employs a range of techniques from value chain mapping, novel benefits management approaches and cultural base-lining to offer a service that is a cut above the transformation initiatives offered by other consultancies.

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Nanomedicines: Depicting human health risks hindering clinical translation

Cecilia Van Cauwenberghe from Frost & Sullivan shares her expertise on the world of nanomedicines, with a special focus on depicting human health risks hindering clinical translation

By way of background, although nanomedicines hold the promise of contributing to provide therapeutically efficient and early-stage diagnostics accuracy, the clinical translation of nanomedicines face numerous challenges. Reproducible manufacturing, efficient scaling-up, appropriate formulation, accurate characterisation, in vivo instability and bioavailability, disease heterogeneity, epigenomic impact, potential toxicity, immune response, regulatory barriers, safety issues and ethical concerns, represent some of the multiple hurdles hindering the clinical translation of nanomedicines.

Furthermore, despite the vast number of opportunities in treating complex and rare diseases, including cancer, derived from the advent of nanomedicines development, the dichotomy between nanotechnology and nanotoxicology remains unresolved. Novel methods attempting to address this concern are emerging driven by the advent of new paradigm-shift approaches.

Nanomedicines overview: The nanoscale effect

Singular features and industry impact

Engineered at an unparalleled small scale, nanomaterials display distinct chemical, physical and biological properties in comparison to those observed in the same compounds at a larger scale. Consequently, it is these features that make nanomaterials extremely versatile and potentially applicable to all industries impacting upon modern lifestyle, including biomedicine. Nevertheless, the same properties could make nanomaterials increasingly unpredictable once interacting with other agents, especially where cells and tissues are concerned.

Nanomedicine constitutes a field of molecular medicine that exploits the ability to control individual properties and combined behaviour of atoms and molecules to build complex functional medicines, ranging from drug delivery vehicles, diagnostic and imaging technologies, analytical tools and theranostic platforms, among many other products, for their application in medicine (Vance et al., 2015; Sharma et al., 2017).

Regarding basic design, a nanomedicines library comprises of a combinatorial approach based on: 1) size, ranging from 1 to 100 nanometers (nm); 2) shape, usually sheet, tube, fibre, sphere, cube; 3) surface, varying charge, crystalline structure, coatings, defects, impurities; and 4) functionality, related to optical, electrical, mechanical, or chemical behaviour. Regarding targeting design, nanomedicines can be structurally, chemically and thermodynamically built to carry small molecules, genes, antibodies, peptides, or radioactive materials, either inside or at their functionalised surface. Among the most commonly used nanomedicines, liposomes, polymers, metals and metal oxides and composites, can be cited. Ideally, nanomedicines respond to certain parameters, such as pH, temperature, or light, to trigger a controlled release of their payload. This controlled action also helps to protect both the host from unintended exposure to an active drug or compound and the drug or agent from being detected by the host's surveillance system or being disintegrated by an adverse microenvironment. Therefore, a great specificity and fine-tuning control must be guaranteed (Etheridge et al., 2013).

Clinical validation: The nanotoxicity potential

Understanding complex biology

Overall, biological effects induced by nanomedicines are associated with their fluctuating, random and sometimes unstable physicochemical behaviour within tissue microenvironments. Naturally, through the complete past decade, notable efforts have been

devoted to developing suitable in vivo, in vitro and in silico toxicity testing assays, intending to assess nanotoxicity. One of the first impediments found is related to nanomaterials insolubility and tendency to aggregate, which derives from all types of test sensitivity failures and significant interference with optical measurements, hence remarkably challenging test validation methods.

Furthermore, the extremely high degree of variables because of a potentially unlimited set of nanomedicines constructions, along with the multiple biological functions and pathways impacted by each nanomedicine, make conventional test validation obsolete (Hare et al., 2017).

Accordingly, while the development and expectations of nanomedicines generally increase, a standard methodology for safety testing of nanomedicines and human health risk assessment is yet to be instituted. Meanwhile, in vitro human cell culture models and in silico approaches combining molecular biology, artificial intelligence and adaptive omics data analytics, more oriented to mimic complex biology, are gaining attention.

Concerning epigenetic regulation

An aspect that cannot be ignored when analysing the human health risks of nanomedicines pertains to their interaction with the genetic material and potential induction of genotoxicity and mutagenicity. By mediating inflammatory responses and oxidative stress process, nanomedicines may trigger epigenetic modifications related to the onset of cancer. DNA methylation, histone modifications and interacting regulative non-coding RNAs, constitute the epigenetic mechanisms strictly regulating gene expression in both the normal and disease microenvironment (Van Cauwenberghe, 2018a).

Consequently, nanomedicines validation requires a solid demonstration of null nanomaterial-induced genotoxicity, that is, nanomedicines must not impair the expression of genes involved in DNA methylation reactions, methylation or acetylation of histones and/or expression of micro RNA (Smolkova et al., 2017).

Meeting artificial intelligence (AI)

Cellular functions are controlled by sophisticated communication routes and signalling pathways between cells, driven by knotty networks of genes, peptides, proteins and metabolites that interact with each other operating as messengers, sensors, regulators, promoters and/or inhibitors of internal and external signals (Halappanava et al., 2017).

Due to their size and ability to interact at tissue microenvironment levels, nanomedicines studies demand an in-depth knowledge of systems biology complexity to carry out sensitive toxicity testing approaches and drug safety evaluation strategies (Agrahari and Agrahari, 2018). Artificial intelligence (AI), including machine learning and deep learning approaches, among many other developments, is prone to improve the complete nanomedicines development process by exploiting large sets, multisource data, to transform them into usable and actionable knowledge and decision-making tools, while leaving behind years of trial-and-error drug development. By allowing the assessment of dozens of trillion data points in a single tissue sample, the building of multi-physics modelling and simulation and the correlation of thousands of sources, AI platforms can be optimally suited to identify new drug targets and to design novel nanomedicines, while minimising screening time and enhancing patterns identification, among many other applications. The necessary step is a strong combination of AI-based technology with biological sciences, especially metabolomics.

This branch of science allows carrying out the quantitative and qualitative scrutiny of all metabolites present in the human body because of both normal and disease processes in diverse organs and tissues. Hence, technologies based on metabolomics approaches, enable the translation of biological outputs to therapeutic candidates. Moreover, the assessment of drug efficacy and safety can be carried out by detecting changes in metabolite profiles, which can be measured significantly faster and simpler than genetic or protein responses (Van Cauwenberghe, 2018b).

In addition, the smart synergy between omics science and AI technologies may outstandingly help to maximise the benefits of the unique combination of adaptive, omics-based biological data and advanced AI machine learning algorithms to build accurate predictive models for nanomedicines clinical validation.

Final remarks

The clinical translation of nanomedicines presents several hurdles. Indeed, at the very early stages of discovery and development, nanotoxicity, including nanomaterial-induced genotoxicity, constitutes one of the principal challenges to overcome in the future.

Systems-level approaches appear highly promising, especially due to their capability to evaluate individual parts of the system, such as the tissue microenvironment, very precisely, accurately, promptly, systematically and exhaustively. Leveraging terabytes of data generated by a single experiment by high-content omics technologies, the industry is focusing its attention on artificial intelligence (AI) learning approaches allowing assessing, interpreting, organising and controlling the quality and reproducibility of big data generated by each of these systems. Hence, the impact of nanomedicines on the genome, proteome, lipidome and metabolome can be smartly assessed thanks to the development of AI-based intelligent frames for data mining, model curation, statistics visualisation and pattern correlation.

Although still in progress, this technology convergence is expected to significantly impact upon the healthcare sector soon, enabling the emergence of programmable nanomaterials, highly appropriate to precision medicine approaches.

Acknowledgements

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The governance of emerging nano-risk in the semiconductor industry

Dr Dimiter Prodanov from IMEC sheds light on the governance of emerging nano-risk in the semiconductor industry in this summary workshop report

An increasing number of engineered nanomaterials (ENMs) are entering the market in everyday products, from healthcare and leisure to electronics, cosmetics, energy, agriculture, food and transport. Whilst for bulk chemicals, there are established regulatory frameworks dealing with the risk for the consumers, workers and the environment, this is not the case for nanomaterials. This situation has created a vivid community of nanosafety research, with the primary objective of ensuring that society can use nanomaterials safely and with confidence.

On 26th of April 2018, more than 40 representatives of stakeholder communities gathered in Brussels to discuss the risk assessment and governance framework of nanomaterials that are used in semiconductor industry. The workshop, entitled "Governance of emerging **nano-risk** in semiconductor industry", was organised by two H2020 projects – NanoStreeM and caLIBRAte with the support of the Royal Belgian Academy for Arts and Sciences, Flanders.

Nanoelectronics was selected as an interesting use case for risk assessment approaches, due to its rapid innovation cycle and culture of high-profile health, safety and quality management. Moreover, nanoelectronics is one of the key enablers for industrial development and is responsible for 200,000 jobs in Europe and approximately 1 million indirect jobs. Therefore, risk management paradigms adopted by nanoelectronics can have widespread social and economic impacts.

The workshop programme featured three sessions focusing on:

(1) nanomaterial use in the semiconductor industry;

(2) industrial needs and technology **advances** in risk management;

(3) experiences in risk management from nanomaterials producers and downstream users.

Every session was followed by a moderated discussion by a separate discussion panel of experts, who also took questions from the audience. The workshop profiled 10 invited speakers and 11 panellists from academia, public research institutions, industry and the European Commission. While the present article can give only a brief summary of the event, readers are invited to visit the workshop web page and follow the recorded sessions and panel reports.

The workshop fostered a culture of open and lively discussions. Throughout the day, the following challenges were identified:

- There appears to be an exponential growth of ENM entering the market worldwide. This presents both a vital opportunity for rapid economic development and a potential issue in presenting unanticipated hazards.
- It is difficult to reliably predict the hazards and risks related to the use of new nanomaterials. Because of the exponential trend in new materials, the relative lack of resources makes the regulatory approaches challenging.
- There is a clear safety knowledge gap, notably in emission and exposure assessments. Furthermore, toxicity data about nanoforms of nanomaterials are frequently lacking or are of poor quality.
- Many nanotoxicity databases developed to date are not available for public use or the available data covers only a few materials.
- Risk analysis is still technically and methodologically limited. Notably, the available models are very generic and difficult to adapt for everyday use by the industries.

The panellists and the audience discussed a broad range of questions concluding on two pertinent ones:

How can the regulatory framework be adapted to account for the long delays in availability of toxicological and environmental data on nanomaterials, without slowing innovation that comes with the application of these materials?
Discussions confirmed that conventional chemical risk assessment methodology is not adequate for

Concluding discussion panel: from left to right: Georgios Katalagarianakis (EC), Keld Alstrup Jensen (NCWRE), Fiona Moclair (INTEL), Claire Skentelbery (NIA)

newly developed materials or nanoforms entering the market. It can be concluded that nanomaterial risk assessment requires specialised knowledge in toxicology, exposure, emissions and lifecycle, which is not readily available at present outside academic communities.

The complexity of the subject and the substantial time lags when data becomes publicly available poses a definite regulatory challenge. In this perspective, it is very important to build competences and scientific capacity that can streamline the translation from basic science to regulatory science. On the other hand, approaches for grouping of nanomaterials in similarity groups (i.e. such as hazard bands or classes), which are developed by some projects and stakeholder groups appear as a pragmatic methodology to advance. The health and safety assessment can be empowered by use of international standards, such as the ISO/TS 12901-2:2014. Furthermore, experience with proposed generic models to date does not favour a preference over one universal risk assessment framework versus multiple industry/application/material specific risk management tools.

How can upstream developers, suppliers and formulators cooperate with the downstream users in risk assessment guidance and risk management?

Risk acceptance along the supply chain depends strongly on the understanding of the chemical or nanomaterial hazards. Therefore, appropriate communication between the different actors along the supply chain is paramount for the successful management of emerging risks and hazards. The panellists agreed that the available regulatory frameworks, such as the REACH Regulation, can be used to communicate the hazards of nanomaterials along the supply chain. This also includes harmonizing national regulations and providing concrete guidance on testing and data generation for regulatory purposes. It can be also concluded that labelling of nanomaterials can be helpful when suitable communication channels are established.

In conclusion, nanotechnology involves a growing number of industrial applications with a large actual economic impact. Nanotechnology is expected to become a key pillar of the European economy of innovation, so it is very important to foster an open culture of communication of identified hazards and risks to maximise its socio-economic impact. To this end, it is important to identify appropriate sources of information and foster communication channels and training opportunities for all actors along the supply chain.

Acknowledgement

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The World Health Organization: Tackling infectious diseases in Africa

Open Access Government explores the work of the World Health Organization (WHO) Regional Office for Africa in tackling infectious diseases, including tuberculosis (TB)

The World Health Organization (WHO) Regional Office for Africa aims to build a better future for everybody, everywhere. In their view, health lays the foundation for productive and vibrant communities, safer nations, stronger economies and ultimately, a better world. The WHO is known as the lead health authority within the United Nations (UN) system and as such, they help to ensure the safety of the medicines and vaccines that treat and protect us, as well as the air we breathe, the food we eat and the water we drink.

Infectious diseases overview

Communicable, or infectious diseases, are caused by microorganisms like parasites, fungi, bacteria and viruses that are spread, directly or indirectly between people. There are a number of disease-producing bacteria and viruses are carried in the nose, mouth, throat and the respiratory tract. Infectious diseases, such as tuberculosis (TB), leprosy and various strains of influenza (flu) can be spread by coughing, sneezing or mucus on unwashed hands.

Viral hepatitis is a major health concern in the region of Africa, where indeed most people living with hepatitis B and C are not aware that they are infected. Insects, of course, play a major role in the transmission of disease, indeed, bites from Anopheles mosquitoes transmit malaria parasites that can have a devastating effect on high-risk populations, such as pregnant women and children under age five.[1]

Tuberculosis (TB)

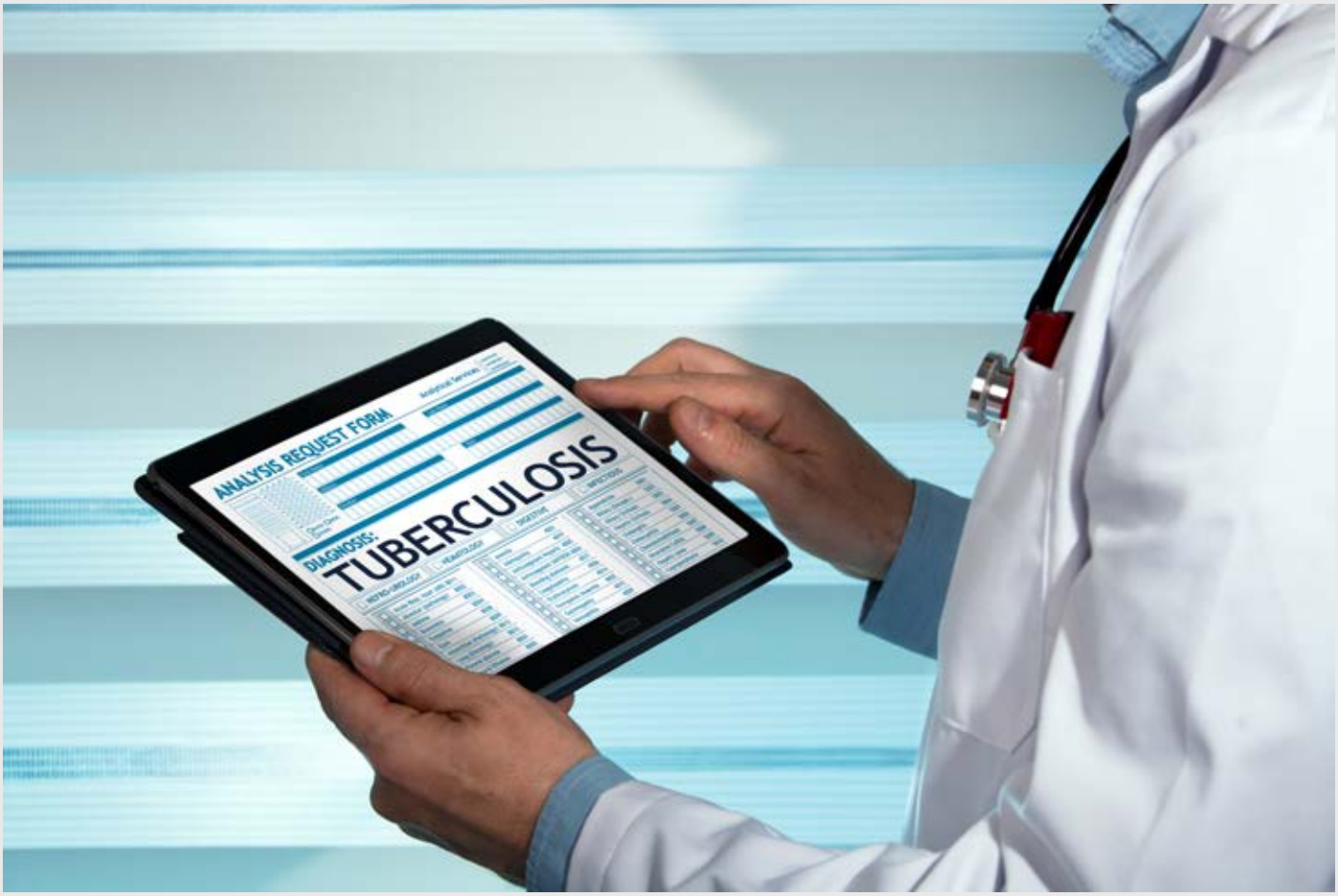
Taking one of the many health areas covered by WHO, we'll now take a closer look at tuberculosis (TB), which is caused by bacteria (Mycobacterium tuberculosis) that often affect the lungs. Today, TB is both curable and preventable. We know that TB is spread from person to person through the air and that when people with lung TB cough, sneeze or spit, they TB germs propel into the air.

According to the WHO, roughly one-third of the world's population has latent TB, which means that those who have been infected by TB bacteria are not ill and as such, cannot transmit it. Added to that, those infected with TB bacteria have a 10% lifetime risk of falling ill with TB. However, individuals with compromised immune systems, such as those living with HIV, malnutrition or diabetes, or those who use tobacco, are at a much higher risk of becoming ill, in the view of WHO.

The symptoms of TB include a cough, fever, night sweats or weight loss can be mild for many months. Without the correct treatment, 45% of HIV-negative people with TB and most HIV-positive people with TB will, unfortunately, die. One important fact about TB is that it is the ninth leading cause of death globally, ranking above HIV/AIDS. The WHO also draws our attention to the fact that a predicted 417,000 people died from TB in the African region (1.7 million worldwide) during 2016.[2]

Taking a real-life example, the WHO website tells us the story of Sunny who works as a fashion designer in Nigeria, started coughing and experiencing chest pains, toe pain and frequent headaches. The symptoms became unbearable and were beginning to impact upon his daily work, so he went to the hospital for a check-up. He was surprised that he tested positive for TB and he explains more about this in his own words:

"When I learnt I had TB, I immediately started treatment. While I was still on the drug I got instructions from my doctors on how I should go about my social life. I had to minimise the way I deal with people, the things I do with them and how close I get to them."[3]



Sunny is an example of the many Nigerians who think that having TB will have an adverse effect on their social relationships, daily. Sunny, in his own words, highlights the importance of getting tested for TB and taking treatment for it, if required.

> "According to the WHO, roughly one-third of the world's population has latent TB, which means that those who have been infected by TB bacteria are not ill and as such, cannot transmit it. Added to that, those infected with TB bacteria have a 10% lifetime risk of falling ill with TB."

"If they come out and take the treatment it is for their (own) good and our country so that the disease will not spread to uninfected people. I'll advise (that) those having symptoms (should) visit the hospital, get tested and if they have the disease, they should go for treatment as it is totally free."

The coordinator of NTBLCP Dr Lawanson Adebola, comments on the stigma attached to TB: "Even though there has been some form of social mobilisation already happening in the community, a lot of people still do not know what TB is all about. TB is not a disease of the poor only as even the rich get infected – that is why it is important that we go out there to hear the perception of people when it comes to TB to be able to design the best messages so that action can be taken".

In closing, the expert Dr Awe Ayodele from the WHO TB team lead explains the important role of the organisation, when it comes to TB: "WHO provides guidelines for the treatment of TB, sanctions and approves the algorithm for the diagnosis, treatment of TB and provide the needed technical assistance in the areas of educating the people, supportive supervisions, training and developing strategic plans" ■

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The detection, identification and monitoring of infectious diseases in Africa

The Southern African Centre for Infectious Disease Surveillance detail the issues around the detection, identification and monitoring of infectious diseases in Africa today

The Southern African Centre for Infectious Disease Surveillance – Africa Center of Excellence for Infectious Diseases of Humans and Animals in Southern and Eastern Africa (SACIDS – ACE), is a One Health partnership of medical and veterinary institutions. The core partnership of the centre is Sokoine University of Agriculture (SUA), Muhimbili University of Health and Allied Sciences (MUHAS) and the Tanzania National Institute for Medical Research (NIMR).

The vision and mission of the centre are rooted in the quest for enhancing Africa's capacity for the science of evidence-based risk management where infectious diseases are concerned through the One Health approach. The focus of SACIDS – ACE is to address infectious diseases in the African endemic settings through a collaborative effort between natural and social sciences to advance the understanding of interactions between humans, animals and the environment to improve public and animal health. The centre proactively pursues the goal of developing an effective African research capacity for infectious diseases through postgraduate training and research programmes that focus on African problems, through the lens of African health and economic development and in context of the global agenda.

In 2008, concerned by the burden of infectious diseases in Africa, academic and research institutions in epidemiologically linked southern and East African countries (Tanzania, Democratic Republic of the Congo (DRC), Zambia, Mozambique and South Africa), we embarked on a pathway towards developing Africa's capacity for research and training in infectious diseases. We formed a One Health partnership of medical and veterinary institutions (i.e. Southern African Center for Infectious Disease Surveillance – SACIDS), aiming for an African-led centre that has progressive relevance to the wider Sub-Saharan region.

We have strengthened training and student-based research, developed competencies in molecular biology and analytical epidemiology, tested innovative approaches and have worked across sectors, institutions and borders, in partnership with internationally renowned centres of training and research excellence. SACIDS is led by Sokoine University of Agriculture (SUA), with core collaboration by the Muhimbili University of Health and Allied Sciences (MUHAS) and the National Institute for Medical Research (NIMR) to consolidate the inter-sectoral partnership. The SACIDS vision and mission is to enhance Africa's capacity for the scientific evidence-based risk management of infectious diseases, through the One Health approach. The SACIDS 'One Health' capacity development focus is to address infectious diseases in the endemic settings of sub-Saharan Africa, with particular attention paid to southern, central and east Africa, through a collaborative effort between natural and social sciences to advance the understanding of interactions between humans, animals and the environment to improve both public and animal health.

According to studies by the World Bank, WHO, FAO, OIE and others, infectious diseases account for around 40-50% of morbidity and mortality in humans today, while for animals they constitute a major constraint to livestock-dependent livelihoods and the single most important barrier to the export of African livestock commodities to the lucrative markets of the OECD and G20 countries. Our focus on infectious diseases is driven by the realisation that Africa probably has the highest burden of infectious diseases in the world and yet, it has the least capacity for risk management in this area. The 2006 Foresight Report on future risks of infectious diseases, emphasises that Africa needs innovative, Africa-led approaches to enable it to make the necessary quantum leap to accelerate the development of its

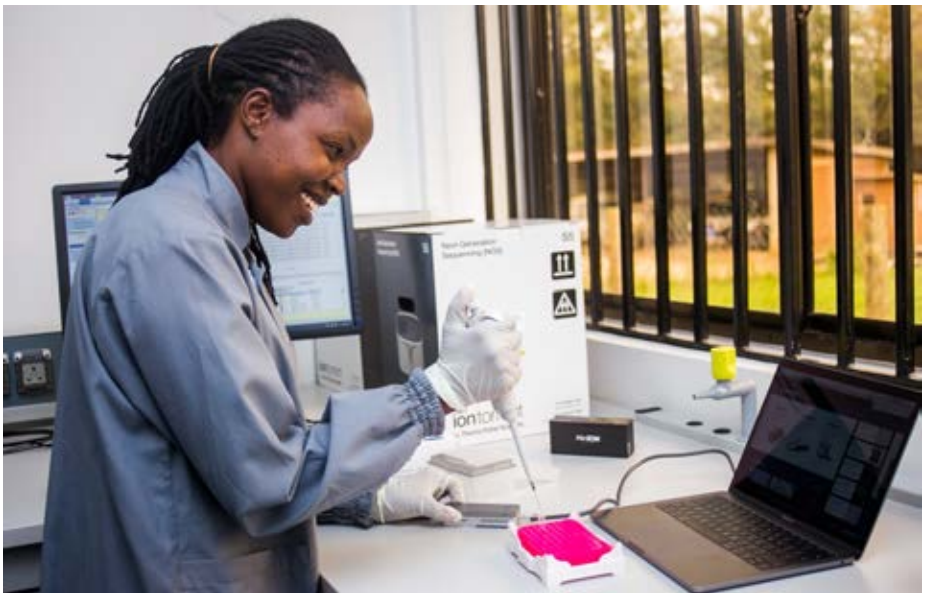
Professor Carolyne Nombo coaching students on gender and equity

scientific capacity for infectious diseases. One such innovative approach, the concept of a Virtual Centre, links several institutions into a single entity to accelerate the training and generation of the necessary critical mass of expertise required.

Ten years after we formed SACIDS, the centre consolidated itself progressively and evolved into two formal regional centres of Excellence for Infectious Diseases of Humans and Animals, under the Sokoine University of Agriculture (the SACIDS – ACE) and the University of Zambia (ACEIDHA). The core strategy of the SACIDS-ACE is based on three principles: (i) Virtual Centre – by which the hosting and leadership of the SACIDS-ACE are by SUA - in very close collaboration with national university and research institutions - with expertise, resources and programmes that are relevant to the objectives of SACIDS-ACE. Specifically, these are Tanzania Veterinary Laboratory Agency (TVLA), Tanzania Wildlife Research Institute (TAWIRI), Muhimbili University of Health and Allied Sciences (MUHAS), Tanzania National Institute for Medical Research (NIMR) and Catholic University of Health and Allied Sciences (CUHAS); (ii) Smart Partnership by which SACIDS-ACE at SUA draw on the expertise and resources of the SACIDS member/ partner institutions in South Africa, Mozambique, Zambia, DRC, Uganda, Kenya and the UK and; (iii) Community of Practice (CoP) approach, by which we undertake research within defined themes and link students and their co-supervisors and mentors across the wider smart partnership into a CoP that constantly shares experience and learning.

Accordingly, the research programme of SACIDS-ACE falls under three strands: (a) Addressing viral disease threats to human health, food security and livelihoods – including emerging diseases, for example, Ebola and vector-borne diseases, for example, Rift Valley Fever (RVF), Dengue, Chikungunya, Zika; as well as livelihoods and food security diseases, such as Foot-and-Mouth Disease, Peste des Petits Ruminants (PPR) and African Swine Fever; (b) Addressing neglected tropical infectious diseases, with a focus on those that cause chronic disease and disability, with severe health, economic and social consequences that impact on the quality of life and livelihoods in low income or marginalised communities, especially women, children and people with disability; including genomic surveillance for anti-microbial resistance; (c) Addressing community level one health security, with a focus on rural, remote, cross-border and marginalised communities, through digital technology supported disease surveillance, epidemiological modelling and integrative EcoHealth approaches, including socio-economics and anthropology.

We recognise that the risk from infectious disease arises from: (i) New pathogens or new strains of existing pathogens through genetic change; (ii) New human diseases from animal



Sylvia Wairimu, a SACIDS-ACE PhD Student, sequencing DNA using the MinION nanopore sequencer at the SACIDS Molecular Biology Laboratory

reservoirs (about 75% of emerging diseases of humans have an animal origin); (iii) Drug-resistant organisms; (iv) Increasing the international movement of people and commodities, including animal commodities, thanks to globalisation; (v) Climate change and; (vi) Human economic activities (for example, settlements that encroach on forest ecosystems) and cultural/social behaviour. Yet, for Africa, there are additional risks associated with endemicity of high-risk pathogens that are either peculiar to the country or have been largely eliminated elsewhere; including the so-called neglected tropical diseases and with Africa's inadequate capacity for risk management of epidemics. The recent Ebola virus disease (EVD) epidemic in West Africa has illustrated both the risk and the inadequacy of response in Africa. It should also be noted that the epidemics of Ebola since 1976 have been characterised by a period of "undiagnosed/unrecognised" disease for two to four months.

The risk management of epidemics relies on four basic tenets: (a) Scientific expertise based on in situ research, diagnostic, epidemiological and socioeconomic analytical competencies; (b) The availability of a critical mass of clinical, public health and animal health expertise; (c) The availability of a critical mass of a diverse expertise and competencies in a variety of operational disciplines, including administrative and logistic expertise and; (d) An enabling health system, infrastructure and governance. We believe that African universities are well suited to contribute to the first two of these tenets.

Since its formation, SACIDS has enhanced collaboration between medical and veterinary member institutions. We have established a track record for innovative approaches to developing Africa's research capacity for epidemic infectious diseases of humans and animals. Our mission is driven primarily by our strategic objective for an African-led development of world-class researchers and research leaders in the country. The centre proactively pursues the goal of developing an effective African research capacity for infectious diseases through postgraduate training and research programmes, that focus on African problems in terms of economic development and the global agenda.

The centre facilities at SUA, MUHAS and NIMR boast a well-equipped molecular biology laboratory, including nucleic acid amplification, conventional capillary DNA sequencing and next generation sequencing using the Ion Torrent and Nanopore MinION sequencers. It has video conferencing facilities and access to the SUA ICT-learning platform. It has set up a TechnoHealth Innovation Laboratory to design digital solutions and support disease surveillance. It has access to conventional virology facilities for cell culture and Biosafety Levels 2 and 3 units for the safe handling of pathogens. It has community radio to link academic and research specialists directly with communities in remote areas.

Our training strategy focuses on developing students who can apply the principles of molecular biology or epidemiology in a One Health context to the understanding and management of infectious diseases, through a tiered postgraduate training programme. The emphasis is on self-driven learning, which aims to develop critical thinking skills and retaining knowledge that leads to self-actualisation. Training focuses on seven strands, i.e.: (i) A taught Master's Programme that involves one year's worth of coursework plus one year's guided research; (ii) A MPhil/MSc- Research that involves two years research; (iii) PhD development; (iv) Postdoctoral programme; (v) Structured short courses for students and practicing professionals that cover a variety of disciplines, that includes bioinformatics, biosafety, statistics; (vi) Annual One Health driven two-week summer schools; (vii)

A novel programme for research leadership and management for PhD students, supervisors and senior academic staff. Course delivery modes include: fully face-to-face, web-enhanced, flipped, blended/hybrid and fully online (e-books, e-resources, e-journals). Laboratory training provides knowledge of both the strengths and limitations of each method to empower students to interpret experimental data.

SACIDS ACE aims to train Master of Philosophy, Master of Science by Research and PhD fellows and recruit postdoctoral fellows. Funding for these fellowships is already available from the Government of the United Republic of Tanzania through the World Bank and the Regional Scholarship Innovation Fund (RSIF) of the Partnership for Skills in Applied Sciences, Engineering and Technology (PASET). The Centre has a rigorous selection and performance appraisal system in place for both students and supervisors. It also offers short courses for students and in-service practitioners and biennial One Health Summer Schools, as well as research leadership and management, including equity issues, such as gender and marginalised communities.

The core partnership for the centre is SUA, MUHAS and NIMR. National Partners are the Catholic University of Health and Allied Sciences (CUHAS), Tanzania Veterinary Laboratory Agency (TVLA) and Tanzania Wildlife Research Institute (TAWIRI). Regional Partners are the South African National Institute for Communicable Diseases (NICD); The University of Zambia (UNZA); Stellenbosch University, Division of Molecular Biology and Human Genetics; University of Pretoria Faculty of Veterinary Science; Eduardo Mondlane University (UEM/EMU); University of Kinshasa (UNIKIN), The Biomedical Research Institute, Kinshasa; the ARCOnderstepoort Veterinary Institute (ARC-OVI), South Africa; The Uganda Virus Research Institute (UVRI); The Kenya Medical Research Institute (KEMRI) and; the International Livestock Research Institute–Biosciences eastern and central Africa (BecA) hub in Nairobi, Kenya.

Beyond Africa, partners are the London School of Hygiene and Tropical Medicine (LSHTM), the Royal Veterinary College (RVC), the London International Development Center (LIDC), the Pirbright Institute (TPI), Ranmore Consulting (UK) and the Policy Institute of King's College, University of London, plus a wider international collaboration on a tactical basis. Our institutional membership of CORDS (Connecting Organisations for Regional Disease Surveillance) enhances our South-South-North networking abilities on infectious diseases by linking us with institutions, organisations and networks in Southeast Asia, Middle East, Southeast Europe, Northern Europe and the U.S., as well as with WHO, OIE and FAO. SACIDS continues to explore opportunities for additional international partnerships in a South-South-North Smart Partnerships that aims to enhance Africa's capacity for infectious diseases of humans and animals in a One Health approach. To this end, we have already established linkages with Korea Institute of Science and Technology (KIST) in the Republic of Korea, The Oswaldo Cruz Foundation in Brazil and Virginia Polytechnic Institute and State University (Virginia Tech) in USA.

Industry partners are ZENUFA Tanzania Ltd and the Botswana Vaccine Institute (BVI). We are currently developing an in-house capability for biologicals (vaccine and diagnostics) development and trials through a USAID collaborative grant with the University of Texas El Paso and link with a Moroccan commercial company (MCI). In this vein, a conceptual framework for developing a SACIDS Innovation Hub for partnership with industry and the private sector is defined.

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The current status of tuberculosis vaccine development

Helen McShane, Professor of Vaccinology at The Jenner Institute, University of Oxford reveals the current status of tuberculosis vaccine development in the world today

Tuberculosis (TB), a disease caused by the pathogen *Mycobacterium tuberculosis (M.tb),* is currently responsible for more deaths than any other pathogen. In 2016, there were 10.4 million new cases of TB throughout the world and 1.7 million deaths[1]. How can a disease that has been around since the Pharaohs still kill so many people in the 21st century?

It is estimated that one-quarter of the world's population are latently infected with *M.tb* and are at risk of reactivation of this latent infection. The emergence of multi and extensively drug-resistant strains makes the need for new tools with which to control this epidemic even more urgent. Better diagnostic tests would allow earlier detection and reduce onward transmission. More effective antibiotics are needed to treat drug-resistant strains. However, the most cost-effective way to control any infectious disease epidemic is with effective vaccination.

The only licensed vaccine against TB, Bacille Calmette Guerin (BCG), was first developed in 1921 and is an attenuated strain of *Mycobacterium bovis*. When administered at birth, BCG confers consistent and reliable protection against TB meningitis and other forms of disseminated disease. However, the protection conferred against pulmonary disease is very variable and is lowest in low and middle-income settings, where the current burden of disease is greatest[2].

M.tb is a complex intracellular pathogen adept at subverting the host immune response. Understanding the immune response needed for protective immunity is critical to the development of an effective vaccine. The lack of validated immune correlates of protection, together with the uncertain predictive value of animal models, are the most important challenges to successful vaccine development.

Vaccine development

To retain the protective effects of neonatal BCG against disseminated disease, there are two main strategies being pursued for the development of an improved vaccine. The first is to boost BCG with a subunit vaccine, comprised of one or more antigens, delivered either as a recombinant viral vector or as a protein/adjuvant vaccine. An alternative strategy is to develop a replacement BCG vaccine, either by genetic engineering of BCG or by the rational attenuation of *M.tb*.

MVA85A, a recombinant attenuated vaccinia virus expressing the *M.tb* immunodominant antigen 85A, was the first subunit TB vaccine to enter into clinical trials in 2002 and the first to complete efficacy testing in 2013. Despite being well tolerated and promising immunogenicity in early studies, MVA85A was only modestly immunogenic in BCG-vaccinated South African infants and did not improve protection compared to BCG alone[3]. Samples from this study have, however, been used to identify immune correlates of protection, which will guide future vaccine development.

"In 2016, there were 10.4 million new cases of TB throughout the world and 1.7 million deaths. How can a disease that has been around since the Pharaohs still kill so many people in the 21st century?"

Since the MVA85A efficacy trial, the focus within the field has shifted from infant to adolescent vaccination, because of a recognition of the role adolescents play in transmission. The focus has also shifted from prevention of disease (PoD) trials, which are large and expensive, to prevention of infection (PoI) trials. As the incidence of infection is greater than the incidence of disease, PoI trials require fewer subjects and shorter follow up and are, therefore, less expensive.

The results of the first PoI trial were reported in the TB Global Forum meeting, Delhi, February 2018[4]. In this trial, BCG revaccination in adolescence was associated with a significant reduction in the exploratory endpoint of incidence of sustained *M.tb* infection. There was no effect on the primary endpoint of *M.tb* infection. A protein/adjuvant subunit vaccine,

H4/IC31, was also tested in this trial and yielded a modest significant effect.

Novel strategies currently under development include the assessment of aerosol delivery of new TB vaccines, direct to the respiratory mucosa, with the goal of inducing a host protective immune response at the site of natural infection[5].

Furthermore, efforts to develop a controlled human mycobacterial challenge model, to aid vaccine development and selection, are underway[6]. Such human challenge models have been pivotal in the development of malaria vaccines. New vaccine networks such as VALIDATE[7] and HIC-VAC[8], which are funded by the Global Challenges Research Fund, aim to expedite the development of vaccines by fostering novel collaborations.

After decades of neglect there is much excitement in the field, but it is critical to continue the recently gained momentum if we are ever to have a more effective vaccine. The iterative assessment of promising vaccine candidates in human efficacy trials remains a critical step in the process, particularly in the absence of validated immune correlates and predictive preclinical animal models.

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VALIDATE
VAccine deveLopment for complex Intracellular neglecteD pAThogEns

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Diabetes: A Global Health Challenge

Professor Nam H. Cho, President of the International Diabetes Federation (IDF) shares his expert views on the rise of diabetes across the globe

Diabetes continues to rise in prevalence across the globe. The International Diabetes Federation (IDF) estimates that there are nearly half a billion (425 million) people currently living with diabetes around the world.[1] The numbers are vast – almost too vast to comprehend. If diabetes were a country, it would be bigger than the United States and behind only India and China in terms of its population. A combination of factors including physical inactivity, poor diet, rapid urbanisation and an ageing population are adding to the numbers living with diabetes.

Professor Nam H. Cho, President of the International Diabetes Federation (IDF)

Between 5 and 10% of all diabetes is Type 1 where people cannot produce sufficient insulin. The remaining 90-95% of the global diabetes burden is Type 2 diabetes, where people cannot properly use the insulin they produce.

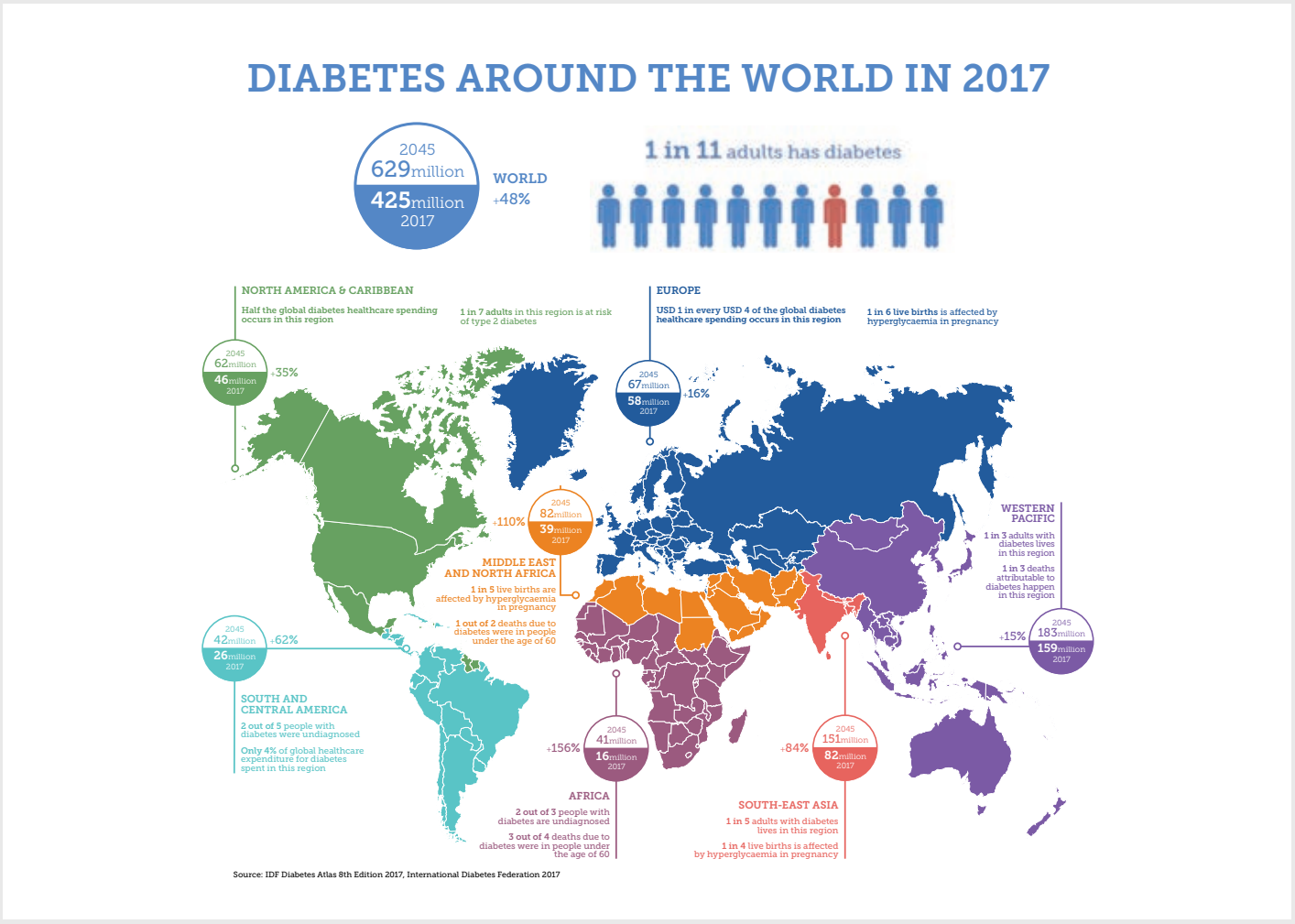
Alarmingly, four in five people with diabetes live in low- and middle-income countries, where adequate resources for diabetes management and prevention are scarce. Half of the people currently living with diabetes are unaware of their disease, resulting in a higher risk of harmful and costly complications. Diabetes is a leading global cause of cardiovascular disease, a leading cause of blindness, of kidney failure and of lower-limb amputation.

Diabetes belongs to the top ten leading causes of death globally. In 2017, IDF estimated that diabetes was responsible for four million deaths, with half of them on average occurring prematurely before the age of 60.[1] The main causes of death among people with diabetes result from cardiovascular and renal complications.

Diabetes has negative implications for human development and the achievement of global development goals. Preventable deaths from diabetes and the loss of the workforce due to its complications are detrimental to economies worldwide. IDF estimates that the global direct healthcare costs from diabetes reached $727 billion in 2017.[1] If we include the indirect costs, the economic impact of diabetes exceeds $1trillion.[2] Governments worldwide are struggling to meet the cost of diabetes care and the financial burden will continue to expand due to the growing number of people affected. Health systems in many countries are unable to provide effective diabetes care, due to limited resources and a shortage of trained health professionals.

If not addressed, diabetes threatens to overwhelm healthcare systems and hinder economic growth in many countries. We clearly need a robust and more dynamic response from all sectors of society.

There is strong evidence that investing in diabetes prevention, education and care is a cost-effective way to tackle diabetes and its complications. In most cases, Type 2 diabetes could be prevented through lifestyle change and the promotion of healthier environments. The earlier someone is diagnosed and given treatment or taught how to care for their diabetes the more chance they will have to live a long and healthy life.



Much can be done to promote knowledge exchange and understanding of recent scientific advances to help drive policy change to ensure that new solutions relating to the detection and treatment of diabetes are available, accessible and affordable to all. Health professionals in primary healthcare should be adequately and appropriately trained about diabetes prevention and care and provided with the necessary screening tools and diabetes medications.

As part of the 2030 Agenda for Sustainable Development, the member states of the United Nations set an ambitious target to reduce premature mortality from NCDs – including diabetes – by one-third; provide access to affordable essential medicines; and achieve universal health coverage, all by 2030.

Effectively addressing the burden of diabetes does not just happen. It is the result of a collective consensus, commitment and public investment in interventions that are affordable, cost-effective and based on the best available evidence.

As the world's largest civil society organisation serving to advance diabetes care, prevention and a cure, IDF is calling for all nations around the globe affected by the diabetes pandemic to work towards the full implementation of the Sustainable Development Goals and strengthen awareness of diabetes to create a brighter future for generations to come. ■

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Diabetes: A commitment to growing international research, education and innovation

Janet Jarvis from Leicester Diabetes Centre tells us about their international research, education and innovation in the field of diabetes

Founded in 2012, the Leicester Diabetes Centre is an international centre of excellence in diabetes and long-term chronic conditions, responsible for world-leading clinical research, evidence-based education and cutting-edge innovation. Based at the Leicester General Hospital, it is now one of Europe's largest diabetes care facilities with a multidisciplinary team, publishing between one and two academic papers per week.

As a partnership and collaboration between the University Hospitals of Leicester NHS Trust and the University of Leicester, Leicester Diabetes Centre is uniquely placed bringing together clinical care, research and academia.

The centre's pioneering work has driven standards in diabetes care worldwide, uncovered new insights about prevention and the impact of treatments, adding to the global evidence base on a condition posing a major threat to world health.

A state-of-the-art hub spanning 4,000 square metres, the centre includes research clinical space, a fully equipped specialist physical activity laboratory and wet lab. Complete with seminar rooms and modern conference facilities, it provides a world-class teaching environment for healthcare professionals.

Leicester Diabetes Centre has recently been accredited by the International Diabetes Federation (IDF) as a Centre of Excellence in Diabetes Care and an IDF Centre for Education. The centre's directors Professor Kamlesh Khunti and Professor Melanie Davies have been named in the top 10 diabetes experts globally on a list published at the American Diabetes Association meeting in Boston, the U.S. The centre is proud to have been selected to represent Leicester as one of only nine cities in the world in the Cities Changing Diabetes Project. The team is looking forward to working towards sharing solutions and driving positive action forward to fight the challenges caused by diabetes around the world.

Post graduate level training: Improving care through learning. Enhancing knowledge and confidence in diabetes care

The world prevalence of diabetes amongst adults is increasing year on year, making diabetes care one of the biggest medical challenges faced by healthcare professionals globally. This rising epidemic has increased the demand for services from personnel trained to deliver high-quality care.

To address this demand, working with the University of Leicester, the Leicester Diabetes Centre delivers a range of post graduate qualifications, both campus-based and distance learning,

including a Post Graduate Certificate, a Post Graduate Diploma and MSc.

Modules from these programmes can also be accessed as stand-alone accredited MSc level short courses for CPD. Studying is undertaken at the heart of clinical NHS services led by experienced clinicians from a multi-disciplinary team. The course team places student well-being as a priority and all students registered for a higher award receive ongoing support from a personal tutor.

The courses are ideal for healthcare professionals who wish to specialise in diabetes, from either a primary or secondary care background. The courses give participants the chance to either study within the centre or have the flexibility of distance learning. All courses are interactive and use innovative methods for learning and teaching.

Students benefit from the specialist knowledge of the experienced and high-profile academic staff from the Leicester Diabetes Centre and the University of Leicester. The ongoing research published by the centre ensures course content is up to date and topical.

The courses comprise a range of modules, combining the most topical thinking around clinical care and research in adults with practical examples of how novel research and evidence-based diabetes care can be applied in real life, clinical settings.

The qualifications address the learning needs of healthcare professionals from around the world, encourage multidisciplinary team working and give clinicians the knowledge and expertise necessary to meet the healthcare needs of people with diabetes.

This year, the MSc team were delighted to receive a superstar award from the University of Leicester Students Union for ' Best personal tutor, best support staff and best practice in inclusive learning and teaching.'

Our students say:

Diabetes Specialist Nurse Graduated 2015: ***"I learnt so much which I have been able to use in my present role today. I would thoroughly recommend it to healthcare professionals."***

Diabetes Specialist Nurse Graduated 2016: ***"It's a great course. There are a couple of core modules plus a variety of option modules. Theory sessions are underpinned by current evidence and trial data."***

Medical Doctor Graduated 2017: ***"The PG Dip has exceeded my expectations across all areas. The weekly work is focused and applicable to my clinical practice and the learning resources are varied, comprehensive and interactive."***

Current Student MSc Distance Learning: ***"A great way to learn and keep yourself up to date on the global urban disease that is diabetes."***

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Type 2 diabetes: Progressing novel scientific insight into new medicine

The gap in the long process of progressing a novel scientific insight into a new medicine is often called "the valley of death". Read below to understand how the strategic alliance between University of Oxford and Novo Nordisk is aiming to combat type 2 diabetes by bridging this gap

The gap between translating basic research discoveries into medicines is often called "the valley of death". The process of progressing a novel scientific insight into a new medicine is long, challenging, labour-intensive and expensive and all too often exciting ideas are lost along the way. The strategic alliance between the University of Oxford and Novo Nordisk aims to bridge that gap, by marrying leading academic science with the best of pharmaceutical research and development capabilities.

Translating knowhow from academia to pharma

Fuelled by an obesity pandemic, type 2 diabetes affects more than 379 million people[1] and is today the fastest-growing chronic disease on a global level[2]. It is this challenge that research in the alliance between the University of Oxford and the Novo Nordisk Research Centre Oxford (NNRCO) aims to address. Since the NNRCO was announced in January 2017, the stated ambition is to enable scientists from Novo Nordisk and the University of Oxford to collaborate to discover innovative approaches for treating type 2 diabetes.

The total investment from Novo Nordisk is expected to be around 1 billion Danish kroner (115 million British pounds) over a period of 10 years[3]. The centre focuses on the early-stage innovation that often falls in the "valley" between fundamental insights and clinical development. It aims to have a substantial impact on the future treatment of type 2 diabetes and its complications. But what makes the collaboration unique? The answer lies in bringing the right translational research insights into a strong collaboration between academia and industry.

> "I am very motivated by the activities that we see here at the research centre every day. Being able to bring excellent fundamental scientists from the University of Oxford together with experienced researchers and clinicians from Novo Nordisk to translate their findings into tangible ideas for further development brings increased hope for patients".

Mads Krogsgaard Thomsen, Chief Science Officer in Novo Nordisk says: "Novo Nordisk has worked to treat and potentially cure diabetes for almost 100 years and is a world leader in diabetes care – bringing a deep disease understanding and knowledge of working with state-of-the-art in vitro and in vivo models. Scientists and clinicians from the University of Oxford and Novo Nordisk are in an exciting position together to identify early research outcomes with the most promise for new medicines. And for those with the most potential, the entire pharmaceutical 'machinery' will be activated to advance a drug target through the drug development pipeline".

The University of Oxford has been crowned the best university in the world by Times Higher Education[4] and brings many years of world-class fundamental research to the strategic alliance. In addition to the alliance and the NNRCO, general discovery within the field of diabetes is supported via another University of Oxford and Novo Nordisk collaboration, the Novo Nordisk Fellowship Programme. Each year this programme supports a group of researchers and clinical research fellows to work on basic science in the field of type 2 diabetes and associated complications.

Sir John Bell, Regius Professor of Medicine at the University of Oxford says: "We see the collaboration with Novo Nordisk as an outstanding opportunity to mix competence embedded at our campus with Novo Nordisk's ground-breaking research and results in diabetes. This collaboration underlines the importance of shared research and cutting-edge science across boundaries. Employees

The NNRCO aims to translate fundamental science into potential medicines for people

at NNRCO and researchers at the University of Oxford will have the opportunity for daily interaction to share knowledge and insights that will potentially produce new medicines for people living with type 2 diabetes and its complications.'

"Novo Nordisk has worked to treat and potentially cure diabetes for almost 100 years and is a world leader in diabetes care – bringing a deep disease understanding and knowledge of working with state-of-the-art in vitro and in vivo models."

Bringing hope for patients

It is cross-fertilisation between academia and pharma that is the ultimate goal of the NNRCO, which by many is called 'a hybrid institute'. To date, it employs 20 researchers who are already involved in research projects together with colleagues from Oxford University. Interim site head of the NNRCO, Allan Ertmann Karlsen says: "I am very motivated by the activities that we see here at the research centre every day. Being able to bring excellent fundamental scientists from the University of Oxford together with experienced researchers and clinicians from Novo Nordisk to translate their findings into tangible ideas for further development brings increased hope for patients".

1 422,000,000 people with diabetes/ 90% of them have type 2 diabetes

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Diabetes care at the University of Salford

Dr Danny Metoo from University of Salford explains the extent of diabetes in the world today and the various courses on offer in the field

In the UK, as elsewhere in the world, the prevalence of diabetes has – according to the WHO and the IDF – reached epidemic proportion and is projected to rise to 552 million by the year 2030, peaking to a staggering 642 million by the year 2040. A person with diabetes potentially faces a reduced life expectancy of between six-20 years.

The irreversible micro-vascular complications resulting in damage to the eyes (retinopathy), the kidneys (nephropathy), the nerves (neuropathy) and macro-vascular complications, namely cardiovascular diseases (heart attacks and stroke) and insufficiency in blood flow to the legs are associated with considerable human, social and economic costs and accounts for 10% of the total healthcare resource expenditure in the UK. This relentless diabetic epidemic means that its management has become a significant healthcare challenge in the UK and worldwide.

The continued decline in funding growth is unlikely to meet demand driven by an ageing population with chronic health conditions, such as diabetes. It is, therefore, imperative that healthcare professionals are equipped with the necessary cutting-edge research-based knowledge, skills and confidence to empower people with diabetes to effectively manage their condition in a cost-effective manner, with a view to prevent complications and improve their quality of life.

Course information:
The MSc in Diabetes Care at University of Salford will enable you to:

- Acquire specific skills in areas such as critical thinking, research methods and communication skills;
- Develop your critical analytical skills and;
- Enable you to deliver high quality, evidence-based care to empower people with diabetes to self-manage their condition.

This course has both full-time and part-time routes, comprising of four 16-week semesters which you can take within one or three years, allowing you to exit with MSc, PgDip or PgCert award.

https://www.salford.ac.uk/pgt-courses/advanced-diabetes-care

The programme comprises the following modules:

- Diagnosis, Classification & Prevention of Diabetes Mellitus (30 credits);
- Therapeutic Advances in Diabetes & Self-care Management (30 credits);
- Diabetes Related Complications & Management in the Marginalised Groups (30 credits);
- Research methods (30 credits) and;
- Dissertation (60 credits).

What do people say about this programme?

"I came to the course already with some diabetes knowledge and it has been invaluable to formalise the information I have been using in my practice. The timetable was well thought out, helping me to provide excellent care for people with diabetes, bringing together local experts to help teach the group. I felt supported by experts at the University and studying for my MSc at Salford has already sparked a new passion – I am thinking about my next steps in study."
Dan Howarth

"A person with diabetes potentially faces a reduced life expectancy of between six-20 years."

"This course provides a balance between theoretical and clinical skills and helped develop my level of critical thinking through participation in the simulation laboratory, group discussion and presentations. Implementing this knowledge in the day-to-day care of patients has been very useful. We were taught by tutors who are passionate about diabetes and who shared their expert knowledge in diabetes with enthusiasm. The knowledge and skills gained through the course has helped me to acquire a job as a community specialist diabetes nurse."
Isabelle Latani Boudop

"I chose to study diabetes care because this condition is growing in prevalence worldwide with devastating impacts on individuals' health and on societies. I'm a family physician with a special interest in diabetes and this course helped me to confidently deliver better management to my patients."
Hanan Humaidan

Conferences and short courses with OneCPD
OneCPD, Salford's Continued Professional Development regularly runs conferences. These are ideal for updating knowledge, networking and keeping abreast of the latest policy, practice and research developments in the field.

Diabetes Conference 2018: Prevention and Patient Centred Care
Join us for the Diabetes Conference 2018 where expert speakers will explain how the NHS can transform its approach to both prevention and treatment. Understand how to move towards a patient centred care model, identify vulnerable groups in need of additional support and see how new technology can facilitate self-management.

Date to be confirmed: register your interest here.

Diabetes management in the 21st century
A one-day diabetes management course designed for anyone involved in supporting people with diabetes. During the course of the day, participants will be provided with a comprehensive, up-to-date evidence-based knowledge of diabetes and diabetes management in order to further enhance their existing skills in providing high-quality care to people with diabetes.

Date to be confirmed: register your interest here.

Bespoke training and consultancy
We can develop bespoke training to meet the specific needs of your workforce, delivered here at Salford, on-site in your locality and through a blend of face to face work-based learning and online delivery methods to suit your needs.

Send us a message here and we'll get in touch to discuss your needs.

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NHS England Diabetes Prevention Programme

NHS England's Diabetes Prevention Programme is placed under the spotlight by Open Access Government

NHS England's Diabetes Prevention Programme takes a personalised approach to tackling one of the biggest challenges facing the health service.

The statistics on diabetes in England are stark. Type 2 diabetes, where the body doesn't produce enough insulin or the body's cells don't react to insulin, affects around 3.5 million people, accounting for nine out of 10 of all cases of diabetes.

One in six patients currently in a hospital has diabetes and dealing with the condition and its potentially devastating complications, which can include sight loss, limb amputation and being a contributing factor to kidney failure, heart attack and stroke, costs over £6 billion every year.

Type 2 diabetes is closely linked to obesity and a lack of exercise – poor diet and being overweight are all risk factors for developing the disease. There is, however, strong evidence that onset can be delayed – or stopped – through a range of lifestyle changes.

Speaking at Diabetes UK's Professional Conference in March 2018, NHS England chief executive Simon Stevens said: "Obesity is the new smoking and the scale of our response needs to match the scale of the crisis."

Part of this response has seen Stevens order hospitals to remove super-sized chocolate bars and sugary stacks from shops, as well as the launch of a voluntary scheme for NHS trusts that aims to reduce sales of sugary drinks to 10% or less of sold beverages. Some trusts have banned sugary drinks altogether.

During the last two years, NHS England, which every year distributes £100 billion in funding to commission health services, has also been rolling out the Healthier You NHS Diabetes Prevention Programme to help those at high risk of developing Type 2 diabetes reduce that risk – and potentially avoid diabetes altogether – through face-to-face support.

Personalised interventions can include education on lifestyle choices, such as drinking less alcohol, advice on how to reduce weight through healthier eating and bespoke physical activity programmes.

The NHS Diabetes Prevention Programme is the first nationwide initiative of its kind in the world. In December 2017, the first set of analyses of the programme showed it had exceeded expectations.

Between June 2016 and March 2017, it received 43,603 referrals – 16% higher than forecast. Attendance for men, for people from black, Asian and minority ethnic (BAME) groups and for those from the most deprived areas, suggest the programme had reached both those at greater risk of developing Type 2 diabetes and those typically less effective at accessing healthcare.

Subsequent analysis by NHS England and Public Health England showed that another 70,000 people have been referred since March.

In March 2018, Simon Stevens provided the Diabetes UK conference with a further update. In the 21 months of the rollout, more than 154,000 people had been referred, with around 66,000 people taking up places.

Just under half of those signing up were men – a much higher proportion than typically attend weight loss programmes. Roughly a quarter were from BAME backgrounds, who are at significantly greater risk of developing Type 2 diabetes.

The programme had also launched digital support to patients, with around 5,000 people benefiting from

a pilot project to test a range of apps, gadgets and wristbands.

In 2017-18, NHS England invested around £42 million to advance care and treatment for diabetes patients and Stevens confirmed a further £40 million for 2018-19.

This will help to fund an additional 94,000 education places a year, up to 864,000 extra interventions a year for individual patients, 185 additional staff for new or expanded foot care teams across 80 hospital sites and 96 additional inpatient specialist nurses and related staff.

In a blog to mark the start of Diabetes Prevention Week (April 16-22), Professor Jonathan Valabhji, National Clinical Director for Obesity and Diabetes at NHS England, said Wave 3 of the programme would launch that month, achieving full national coverage.

In addition to exceeding to initial targets for referrals and equity of access, Professor Valabhji said the first sets of encouraging weight loss results are starting to emerge.

"So far, well over 50% of people have completed the flagship scheme in terms of attending at least eight support sessions over a nine-month period – losing an average of 3.3kgs," he wrote.

"However, when excluding those who already had normal weight and BMI but [are] on the programme due to other health and lifestyle risks associated with developing Type 2 diabetes, this average weight loss figure is 3.7kg, 1kg higher than we had predicted at the outset."

He also revealed that nearly 1,400 people had been referred to the digital arm of the programme in its first two months, with more than 820 logging on and accessing diabetes and obesity prevention services.

"Behaviour and lifestyle change is a challenge for us all but for those with diabetes and at risk of Type 2 diabetes, it takes on an even greater focus," Professor Valabhji wrote.

"By putting people in control of their health, the programme is helping to improve the outlook of thousands of people and hopefully next year, this will add up too many more thousands as the gift of technology extends our horizons." ■

https://www.england.nhs.uk/diabetes/

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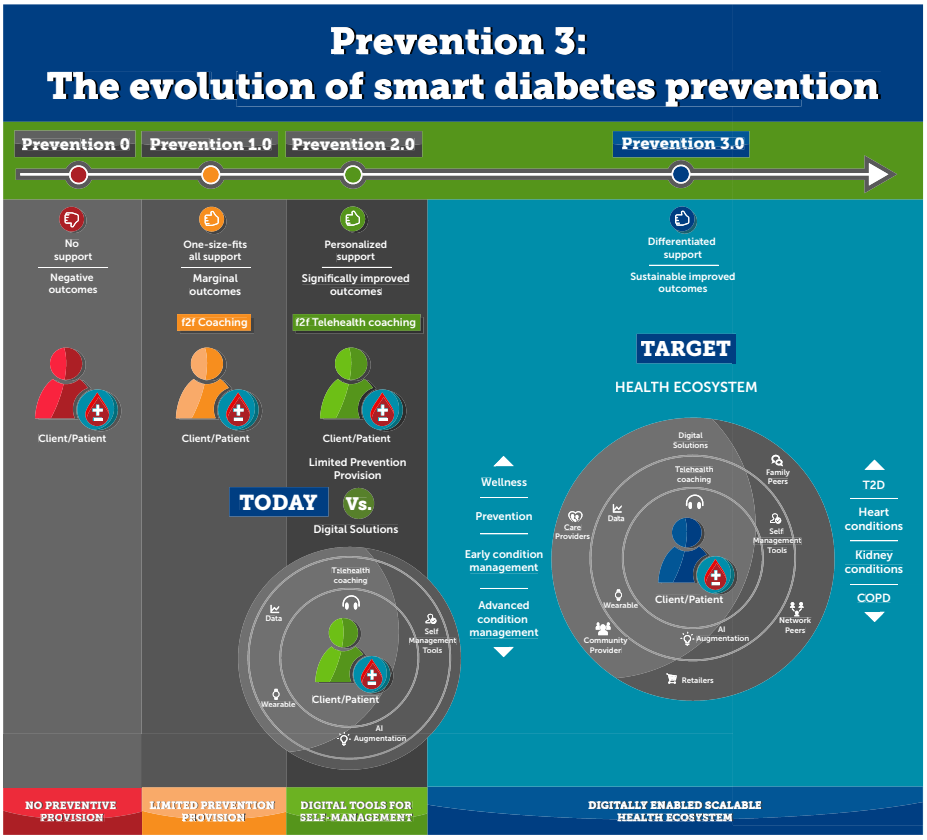
Digitally enabled pathway personalisation: Journey to Diabetes Prevention 3.0

From Diabetes Prevention 1.0 to Prevention 3.0, Hitachi Consulting explains a digitally enabled pathway personalisation when it comes to diabetes

The rising global prevalence of Type 2 diabetes has placed an 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 the risk of Type 2 diabetes onset, leading policymakers in the UK to establish the NHS Healthier You Diabetes Prevention Programme. The 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, whilst giving their 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 collaboration with NHS partners in England, aimed at leveraging clinical expertise, remote telehealth and digital solutions to create a new model of provision, or prevention 3.0.

Collaborating across organisational boundaries

In 2012, Hitachi looked for opportunities to collaborate with NHS organisations in areas of mutual interest focused on innovative solutions addressing social and healthcare challenges. Since then, Hitachi has collaborated with one of the leading NHS trusts in England, Salford Royal Foundation Trust (RFT), Salford Clinical Commissioning Group (CCG) and the University of Manchester to co-design England's first digitally-enabled, telehealth diabetes prevention provision. Supported by rigorous academic evaluation, the programme was selected to participate in the NHS Healthier You Digital Diabetes Prevention pilot in 2017.

Hitachi's Smart Digital Diabetes Prevention solution leverages the collective experience and innovation in technology and clinically-led prevention of Hitachi and our NHS partners in Salford RFT and Salford CCG. By bringing together clinically-led coaching, digital tools and data, we have created a balanced blend of capabilities, assets and insights needed to advance provision towards Prevention 3.0.

Prevention 3.0 – Patient-driven, connected health ecosystem

Hitachi's vision of prevention 3.0 is geared to creating a clinically-effective, sustainable and scalable model of provision, driven by the patient need set within the context of a connected health ecosystem. The core components and enablers making-up prevention 3.0 include:

- **Clinically-led telehealth coaching,** providing human support critical to driving positive behaviour change needed to bring about lifestyle change.
- **Digital tools including wearables,** providing the means for effective self-management and monitoring, establishing the data-points required to create a credible picture of patient needs.
- **Data-driven insights,** providing the basis for personalising pathways, engagement and the nature of support provided to ensure best lifestyle outcomes.
- **Peer support networks,** leveraging digitally-enabled solutions to connect the influence that family and friends can bring to bear with patients, thereby giving them the best opportunity to succeed in changing their lifestyles.
- **AI-augmented coaching support,** leveraging the latest developments in technologies and established data-driven insights to create personalised messaging targeted at identified areas of patient need and progress throughout the pathway.
- **Integrated provider data,** allowing for acute and community care providers to share appropriate data and insights on the patient's lifestyle progress, thereby allowing for the best holistic/integrated care to be delivered to the patient.
- **Signposting to third-parties,** including community, fitness and wellbeing providers as well as food retailers, enabling access to the wider health and wellbeing ecosystem.
- **Personalised pathways,** leveraging data to drive pathway and digital personalisation to ensure the best possible blended support is provided to the patient.

Hitachi's vision of Prevention 3.0 blends clinically-led coaching, digital technologies and tools, as well as data-driven insights to create a patient-driven, connected health ecosystem, personalised to patient needs and geared towards scaling.

Digitally-enabled pathway personalisation

Digital technologies, combined with clinically-led pathways, provide the key ingredients needed to establish and sustain patient engagement. This, in turn, allows the patient to effectively self-manage their lifestyle change, whilst generating the data insights needed to build-up a comprehensive picture of their needs. Digitally-enabled pathways leverage this intelligence to provide:

- **Enhanced patient choice,** providing targeted support based on the needs identified by data-driven insights, allowing the patient to select the range of care options available to them within the programme and the wider health ecosystem.
- **Targeted patient support,** ensuring that coaching and digitally-enabled support is made available when the patient needs it the most, through the best appropriate channels in the wider health ecosystem.
- **Improved patient engagement,** providing a foundation for effective behaviour change critical to sustained lifestyle change.
- **Better health outcomes,** facilitating a sustained reduction in the risk associated with Type 2 diabetes onset and progression to lifestyle-related long-term chronic conditions.
- **Improved patient access,** allowing the patients to access support in remote settings and on-the-go.
- **Reduced cost and improved scalability,** allowing resources to be targeted at identified areas of need and patient choice, to reduce costs, optimise resource productivity and provide scalability and sustainable return on investment.

Hitachi's vision of Prevention 3.0 establishes digitally-enabled pathway personalisation to provide a foundation for enhanced patient choice and support focused on patient needs as a means of securing and sustaining better health outcomes in a cost-effective and scalable manner.

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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[1]. In the UK alone, this figure is 4.5 million people[2]. 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[1].

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[3]. 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[4]; 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[1]; in the UK, for instance, treating diabetes and associated complications represents 10% of the NHS budget, amounting to £10 billion each year[5]. The healthcare challenge presented by diabetes is immense – but it's not insurmountable. 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[6].

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[7].

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[7]. 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 Francoise 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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Tackling the root cause of Type 2 diabetes: Obesity

Kristoffer From, CEO of Liva Healthcare and Simon Pickup, UK Managing Director at Liva Healthcare share their thoughts on why obesity is key to tackling the root cause of Type 2 diabetes

Recent research[1] revealed one in eight people will have Type 2 diabetes by 2045 if obesity continues to increase at its current rate. Last year, at the European Congress on Obesity in Vienna, it was estimated that 14% of the global population are obese and 9% have Type 2 diabetes. By 2045, obesity levels are expected to rise to 22% and 14% are predicted to suffer from Type 2 diabetes. In the UK, obesity levels are at 32% and diabetes rates are predicted to rise by over a quarter, from 10.2% to 12.6%.

Accelerating the global fight against diabetes

These figures cannot be ignored and the global fight against diabetes needs to be accelerated. Type 2 diabetes is a growing health crisis and it also has huge cost implications. According to Diabetes UK, the NHS spends almost £12 billion a year on treating people with Type 2 diabetes[2]. Those with the disease need to monitor their blood sugar levels, potentially take medication and can be subject to a number of complications, including blindness, kidney failure and amputations.

In order to truly tackle Type 2 diabetes, we must tackle the root cause – obesity. According to the pharmaceutical company, Novo Nordisk, globally obesity levels must come down by 25% to prevent Type 2 diabetes rates increasing above 10%. In the UK, to stabilise diabetes rates at 10%, the rate of obesity must decrease from 32% to 24%[1].

The need to change lifestyles

That is no easy task. Health services have, for a long time, relied on traditional, medicine based treatments. However, medicine does not tackle the root cause of obesity. Recently, health services have started to see the potential and the power of lifestyle interventions to tackle obesity and, in turn, Type 2 diabetes. Lifestyle interventions, which involve having a healthy diet and regular exercise, have been found to help patients not only manage Type 2 diabetes but reverse the condition completely.

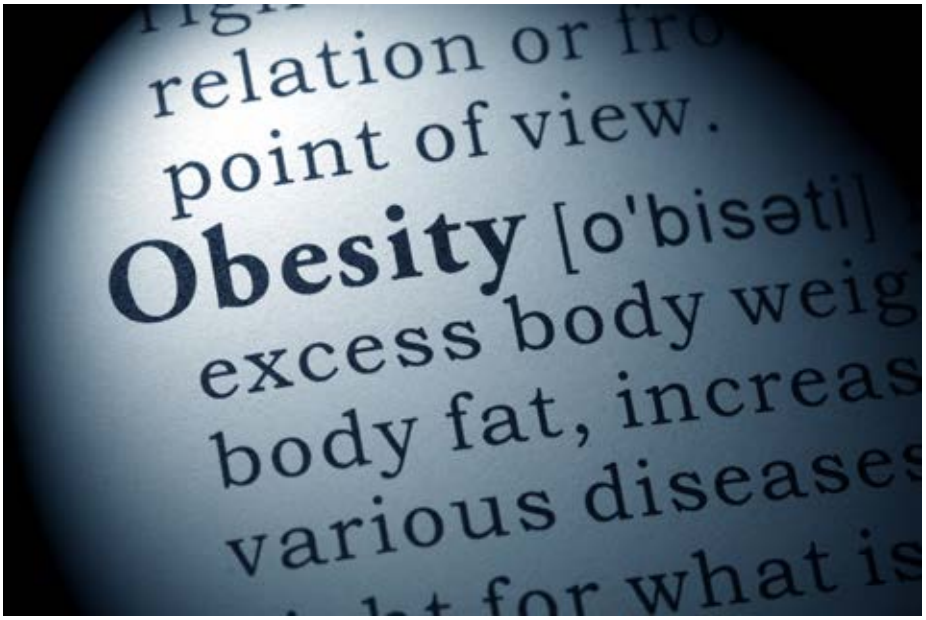
Digital interventions have been helping to facilitate this. The NHS last year launched the Healthier You: NHS Diabetes Prevention Programme digital stream, of which Liva is a part of. For this, we provide patients at risk of developing Type 2 diabetes with an app that connects them to a personal health coach. The patient, with guidance and support from their health coach, sets personalised health and lifestyle goals which they can then track and monitor through the app. The patient can have regular video or text consultations with their coach and access an online support community of other patients, as well as educational information to help them improve their lifestyle. Patients can track information relating to, for example, their sleep, nutrition, exercise levels, blood sugar levels and water intake. The results have been promising with some patients losing up to two stone in their first two months.

> "Amsterdam has shown the power of junk food bans alongside education on how to eat healthier food. Let's hope the UK will follow suit to help bring down obesity rates and, in turn, stabilise and begin reversing Type 2 diabetes rates."

More needs to be done however to help individuals tackle unhealthy lifestyles to reverse the obesity trend. The focus shouldn't just be on adults, but children too. Recent research has revealed a concerning relationship between Type 2 diabetes and childhood obesity. Research from King's College London revealed that childhood obesity can increase the risk of Type 2 diabetes four-fold by the age of 25 compared to children with a normal BMI[3]. This demonstrates the need to prevent obesity from early life and for the government to invest more in engaging the public in obesity prevention efforts.

Inspiration from the Netherlands

Whilst in many places childhood obesity rates are rising, one city where they are falling is Amsterdam[4]. The city has set up a healthy-weight programme which has seen a 12% drop in overweight and obese children. The



programme costs around £5.3 million a year and relies on working with existing professionals such as teachers, doctors, nurses and social workers to enforce a consistent, healthy lifestyle message. Children are taught how to eat healthily, are not allowed sugary snacks or fizzy drinks in school and are encouraged to be active. For those that need a little extra help, fitness classes are offered. The city has also started initiatives, such as banning fast food adverts on the subway. With such impressive and impactful results, it is logical for other cities to follow suit.

Taking action in the UK

The good news is that along with initiatives such as the Healthier You: NHS Diabetes Prevention Programme, initiatives are being set up and put forward to tackle the growing problem of obesity in the UK. The London Mayor, Sadiq Khan, has announced a ban on junk food adverts on London tubes and buses in an attempt to curb the epidemic of childhood obesity. This will mean any adverts that promote foods and drinks that are high in salt, fat and sugar will no longer be displayed on London transport. In other areas, obesity drives have been less successful, however. A national proposal to prevent junk food adverts during prime-time TV was prevented.

In addition, at the time of writing, the UK government is considering implementing bans on junk food deals which would be a welcome initiative. Strategies like this are needed in order to create long-term behavioural change in those who opt for convenience and instead, encourage them to choose healthier, fresh foods. As such, although a ban on deals is helpful, it's unlikely to be effective alone. It needs to be supplemented with promotions to encourage parents to buy more nutritious food and also education for children on the importance of making healthy lifestyle choices. Just how they have done so in Amsterdam.

A bright future

The figures are clear; inaction against obesity has severe consequences. Without initiatives to tackle obesity, diseases like Type 2 diabetes will continue to rise. This will cause a huge medical challenge in the UK, as well as significant cost challenges. Policies need to be implemented to help individuals make behavioural changes to live healthier lifestyles and take people away from relying on medication to mask their diseases. The NHS Healthier You: Diabetes Prevention Programme is one example where lifestyle changes are being implemented. However, efforts need to be made to tackle obesity on a wider scale to prevent individuals from even becoming pre-diabetic. What is more, we need to start helping children. Amsterdam has shown the power of junk food bans alongside education on how to eat healthier food. Let's hope the UK will follow suit to help bring down obesity rates and, in turn, stabilise and begin reversing Type 2 diabetes rates.

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Diabetes: A global epidemic, A local problem

Dr Eleanor D Kennedy, Research Manager at the Diabetes Research and Wellness Foundation explains why diabetes is a global epidemic and at the same time, a local problem

According to the International Diabetes Federation's influential "Diabetes Atlas", the scale of the global diabetes issue is reaching epidemic proportions. One in eleven people – or 435 million – now have the condition. Around 12% of global health expenditure is spent on diabetes and healthcare systems around the world are struggling to deal with the demands for improved treatment and management.

> "Here in the UK, around 400,000 people are living with Type 1 diabetes. The incidence rates are increasing by around 4% per year but the reasons why are not fully understood."

Whilst there are recognised global hotspots like China, India and the USA, many countries are witnessing phenomenal increases in the numbers of people being diagnosed with the condition and it is estimated that, by 2045, the number of people in the world with diabetes will have increased to 629 million. It is important to remember, however, that not all diabetes is the same.

Type 1 diabetes, which is caused by an autoimmune attack of the precious, insulin-secreting beta cells in the pancreas is unrelated to the spike that we are witnessing in the numbers of people with diabetes and it is important not to confuse the two. Here in the UK, around 400,000 people are living with Type 1 diabetes. The incidence rates are increasing by around 4% per year but the reasons why are not fully understood. What is known, is that the condition is caused by a complex interplay of genetic risk and environmental factors. The result is that the person diagnosed with the condition needs to take insulin injections every day to stay alive.

Currently, Type 1 diabetes is not preventable although a lot of research efforts are underway around the world to try to stop the immune-led destruction of the beta cells, including the identification of the genes that may predispose a person to the disease and innovative ways that could stop the antibodies responsible for this destruction from reaching their target tissue.

Type 2 diabetes, unlike Type 1 diabetes, is not an autoimmune condition. In fact, although a lot of pieces of the jigsaw are being painstakingly put in place, researchers are still uncertain about this complex and increasingly common condition. Although it is largely thought to be a preventable condition, a growing number of genes are being identified that can lead a person to be diagnosed with Type 2 diabetes. Many, although by no means all, of the genes are involved with insulin signalling.

Affecting somewhere between 3.5 million and 4 million people in the UK, Type 2 diabetes is characterised by the phenomenon of insulin resistance. Whereas people with Type 1 diabetes have no insulin production, people with Type 2 diabetes can have normal insulin production or even increased levels of secretion, but the cells in the body that respond to this hormone, like in the muscles and in the brain, no longer recognise it. This so-called insulin resistance tends to be more common in obese people leading to a correlation between obesity and Type 2 diabetes. But it is not that simple, as we know that many obese people do not get Type 2 diabetes and many non-obese people do.

As with Type 1 diabetes, the interplay between genetics and environmental factors is being teased out. Diet and exercise are key components of the treatment and management of Type 2 diabetes and new drugs continue to be launched onto an increasingly greedy marketplace. These drugs aim to help people with the control of their blood glucose (sugar) levels.

Whilst international research efforts continue apace, patient education also plays a vital role when it comes to diabetes. By informing people about the dangers of uncontrolled diabetes, the long-term complications like blindness and kidney failure that can be the result – and the link between obesity, poor diet and lack of exercise – healthcare professionals, charities and other not-for-profit organisations play important roles in providing informative and effective patient education. With the annual cost of the treatment of diabetes and its complications soaring towards £10 billion per year in the UK, the NHS can ill afford even more people being diagnosed, so it is time to take control of lifestyle and of patient education and to turn around this modern-day epidemic.

Sarah Tutton, Chief Executive of the DRWF in the UK says: "Diabetes is a global issue that requires collective solution finding. Whilst DRWF (UK) is an independent, autonomous charity working for the benefit of people with diabetes in the UK, internationally, we work with sister organisations in the USA, France, Sweden, Finland and Norway, under the umbrella of the International Diabetes Wellness Network.

"We work together on global awareness and educational campaigns with the aim of helping people recognise the difference between the many forms of diabetes; preventative actions and supported self-management strategies. Additionally, the network enables all groups to collaborate on international research funding projects. Since the first group was established in the US in 1993, the network has committed more than €60 million to diabetes awareness, education and research. DRWF has been a key supporter of islet research and transplant in the UK, with the provision of the DRWF Islet Isolation Facility at the Churchill Hospital, Oxford. This facility is pivotal to the success of a national transplant programme, the clinical element of which is funded by the NHS. The UK is one of just a handful of countries currently providing islet transplants as a clinical therapy for a selection of people with Type 1 diabetes". ■

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Online diabetes competency training: Improving standards and reducing variation

Candice Ward, Lead CDEP Educator from Cambridge Diabetes Education Programme (CDEP) details online diabetes competency training, including the importance of improving standards and reducing variation

Diabetes management is complex, requiring appropriate knowledge to provide optimal diabetes care. The provision of safe, quality care lies within the foundations of healthcare education, continuing professional development (CPD) and evidence-based practice, which are inseparable and part of a continuum during the career of any healthcare practitioner.

The Cambridge Diabetes Education Programme (CDEP), a unique online diabetes healthcare practitioner education resource, is increasingly being recognised as a way by which Clinical Commissioning Groups (CCGs) in the UK can implement far-reaching, cost-effective diabetes education for their staff. CDEP is based on the UK diabetes competency frameworks, which help structure the nature and level of diabetes skills required by all healthcare staff to support safer patient care, improved outcomes and to reduce the financial burden of diabetes.

Beyond providing opportunities for staff to undertake diabetes CPD and obtain accredited study hours and reflection documents, CDEP's clinical feedback portal provides diabetes practice-based evidence for annual appraisals and professional revalidation portfolios.

CDEP offers competencies across five different levels (core, intermediate, diabetes specialist diabetes expert and diabetes consultant) – making it applicable to all levels of staff.

CDEP is endorsed by Diabetes UK, Cambridge University Health Partners (CUHP) and the British Dietetic Association (BDA) and is accredited by the Royal College of Nursing (RCN), the Royal College of Midwives (RCM) and the Royal College of General Practitioners (RCGP).

CDEP is based on adult education principles and is designed to be done in 'bite-size' chunks in appreciation of the very pressured lives healthcare practitioners lead. The overall time taken to complete a topic will vary from person to person, depending on their prior level of knowledge, IT literacy and reading speed. Topics vary in length, depending on the number of competencies, but on average they take between 1-3 hours to complete. Currently, CDEP offers 15 topics in total, which amounts to 30 hours of CPD time if all 15 are completed.

Staff, with appropriate diabetes competencies for their role, tend to find CDEP improves their confidence by validating their knowledge. The demonstration of competencies is reassuring to employers and can be used as evidence of robust clinical quality assurance, in minimising clinical incidents as well as preventing never events. CDEP also make staff aware of the gaps in their knowledge and this is reflected in the improvement in self-reported competency levels and familiarity with diabetes guidelines.

A quote from a practice nurse working in diabetes

"It has been apparent for some years that the depth of knowledge has been varied among healthcare professionals, which can be detrimental to patient care. It also has been difficult to access up to date information and guidelines, which again has an impact on the care delivered.

"On accessing CDEP I have found that I became more confident in delivering diabetes care within both my practice and teaching student nurses and registrars. The resources are second to none and as you are able to access the most up to date research, which has helped broaden my knowledge, and sign post patients to resources that they would find helpful in self-management.

"Using CDEP has been invaluable as a teaching resource as you are able to do as much or as little as time allows, allowing you to access it around work or family commitments. All the nurses in my team have accessed CDEP and found it very helpful, not only for diabetic patients, but other patients with chronic disease.

"I feel very strongly that CDEP has had a major positive impact on my fellow health care professionals and on the care, they deliver."

CDEP's resource library is designed to support the user undertake the competencies and can be accessed prior to, during or following an assessment series. However, we have discovered that healthcare professionals are also using this library as a portal to access resources during clinics to support clinical activity.

On average, 14 people successfully complete a CDEP topic every day of the week. From our own research, completion rates of CDEP are far higher compared to face-to-face education delivered by diabetes specialist nurses, due to the convenience of accessing learning at a convenient time to the user.

To date, CDEP has generated over 7,200 individual certificates following the successful completion of a topic. The average evaluation across all topics showed that 99.6% either confirmed (13.6%) or improved (86% their diabetes competency, confidence or guideline familiarity.

CDEP offers commissioners a unique online reporting portal to view aggregate data regarding the uptake and utilisation of CDEP within their staffing cohort so they can monitor the impact of CDEP, as well as focus diabetes education strategies to support local face-to-face training initiatives and clinical incentives to drive improved diabetes outcomes.

CDEP was designed and piloted by a multi-disciplinary diabetes specialist team consisting of nurses, dietitians, podiatrists, healthcare assistants, general practitioners and diabetologists. Prior to launch, each new topic is robustly tested by the core CDEP clinical team, external experts in the field as well as the target audience to ensure that the topic is fit for purpose. CDEP undertakes a regular review of all the content to ensure it is up-to-date. User feedback is routinely monitored and actioned as appropriate to enrich the platform.

CDEP has a mobile responsive website, which offers a high quality user experience on a computer, tablet or smartphone. CDEP offers timely support to users and commissioners via email, telephone and teleconferences.

If you wish to find out more about CDEP or have a live demonstration of the online diabetes e-learning tool, please do not hesitate to contact us.

RCGP ACCREDITED

BDA The Association of UK Dietitians Centre for Education and Development

CAMBRIDGE UNIVERSITY Health Partners Knowledge-based healthcare

RCM ACCREDITED

DIABETES UK

Royal College of Nursing RCN ACCREDITED

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How digital solutions are having an impact on the self-management of Type 2 diabetes

Yinka Makinde, Programme Director at DigitalHealth.London tells us exactly how digital solutions are having an impact on the self-management of Type 2 diabetes across London in the UK

Can self-management for Type 2 diabetes be significantly impacted by the use of digital solutions? Three of the UK based diabetes digital therapeutic solutions, Changing Health, OurPath and Oviva, who are shaping the future of how Type 2 diabetes can be managed, prove that it absolutely can.

Diabetes costs over 10% of the NHS budget, as quoted by NHS England. Supporting more people to learn to self-manage their diabetes could significantly reduce the financial pressures on the NHS and has, therefore, been identified as a key priority in NHS England's Action on Diabetes and the Five Year Forward View. In light of this, new and innovative ways to manage this condition are urgently required to reduce the growing strain on healthcare systems and improve patient outcomes.

The good news is that better treatments are being discovered that can improve patient outcomes. In addition, new technologies are helping people with diabetes to manage their condition better.

There are also positive developments when it comes to growth in clinically validated health apps on the market. The overall body of clinical evidence on app efficacy has grown substantially, spanning to include 571 studies[1], including 234 randomised controlled trials and 20 meta-analysis studies. Particularly strong evidence now exists for diabetes, depression and anxiety that may be considered by clinical guideline writers for incorporation into the standard of care recommendations. Industry experts say that there are now a handful of conditions with a maturity of digital health efficacy studies, which make them good candidates for adoption and inclusion into clinical guidelines. One of those conditions is Diabetes Prevention, particularly in light of the recent statistic, which showed for the period 2015-2016, only 9% of those eligible for and offered Type 2 diabetes face-to-face group sessions, actually attended them[2].

Local health communities are beginning to put these recommendations into practice. The North West London Collaboration of Clinical Commissioning Groups (CCGs) is a prime example. In an initiative led by Dr Tony Willis, Diabetes Clinical Lead for the North West London Collaboration of CCGs, in partnership with Imperial College Health Partners, (the Academic Health Science Network for North West London), significant improvements were delivered to the health of more than 400 Type 2 diabetes patients, drawn from across 18 different GP practices in North West London, with the help of three smartphone health apps.

During the four-month digital intervention trial, the results achieved were:

- Patients saw a significant reduction in body mass index (BMI), blood pressure and blood sugar (HbA1c) levels;
- Patients lost on average two to three kilogrammes of weight and;
- 118 patients participating provided details of their medication, of that 20% were able to stop taking the diabetes medication metformin during the trial.

Personalised interventions

Digital interventions enable healthcare providers to deliver impactful structured educational programmes cost-effectively and at scale, giving people with weight management issues a better understanding of how their dietary and exercise habits affect their long-term health. To maximise impact, however, the most effective behavioural interventions must be highly personalised to facilitate substantive, lasting lifestyle change, taking individuals' unique circumstances into account too.

Eight years of academic research by Changing Health's Chief Scientific Officer, Professor Mike Trenell and Head of Health Psychology, Dr Leah Avery, has shown that intentions and actions are determined by a whole host of social, environmental and demographic factors: age, ethnicity, gender, socioeconomic status and educational attainment to name but a few.

The Changing Health programme, which combines evidence-based digital education on diabetes and lifestyle with one-to-one support from a dedicated behaviour change coach, was built on this foundation from the ground up. Each behaviour change coach is extensively trained in diabetes, health psychology and the latest behavioural science, with the syllabus, reviewed monthly to ensure it is current. A recent RCT of obesity interventions showed combining education with coaching is 60% more effective than education alone.

Coaches tailor-make a behaviour change programme for each user. Evidence shows three factors – social influences, social role and identity within peer group, and intentions and goals – are the most prominent in shaping our behaviour. These factors are key in determining the most effective intervention for each individual.

As a result, programme users quickly become better engaged with their health and healthcare; and in the North-West London Collaboration of Clinical Commissioning Groups, they saw a 10-point increase in PAM (Patient Activation Measure) scores – equating to 20% fewer hospitalisations and a 20% increase in medication adherence.

Furthermore, there is strong evidence to show that combining expert support from a dietitian, plus high-frequency support, is more effective for helping people improve their health behaviours (Digenio et al. 2009)[3].

Oviva worked with leading NHS experts to develop a new approach, which could be quickly and simply integrated into existing NHS care pathways. This new programme, called Oviva Diabetes Support, has been evaluated across 17 NHS organisations and involving over 2000 people with diabetes. To date this new programme has achieved a 74% attendance rate (compared to 7% in face-to-face programmes) and 26% of people with diabetes were able to put their condition into remission.

> "Diabetes costs over 10% of the NHS budget, as quoted by NHS England. Supporting more people to learn to self-manage their diabetes could significantly reduce the financial pressures on the NHS and has, therefore, been identified as a key priority in NHS England's Action on Diabetes and the Five Year Forward View."

Oviva was inspired by the scientific evidence that by offering such programmes remotely and supported by digital tools, you can increase accessibility whilst maintaining high-quality health outcomes (Appel et al. 2011).

OurPath which has implemented cognitive behavioural therapy at every stage of its programme, using the Behaviour Change Wheel, FOGGS and EAST principles, found that its unique combination of evidence-based structured education (on nutrition, exercise, sleep, stress management and positive psychology); peer group support; personalised health coaching (from a registered dietitian); and tracking technology (smart weighing scales and a wearable activity tracker) has proved that weight loss from digital programmes can be sustainable, demonstrating an average 7.7% body weight loss, even after nine months.

DigitalHealth.London lies at the centre of the revolution in healthcare by creating a "global digital health hub", or a marketplace where the best digital health solutions are nurtured and accelerated for entry and adoption across the UK healthcare system. We have demonstrated, through our work with the NWL CCGs, how we have been able to source the best solutions for commissioners to consider for adoption, as we did with Changing Health, OurPath and Oviva.

So, what further reasons could there be for NOT accelerating the adoption and spread of these technologies for Diabetes Prevention? There is a growing evidence base to support the efficacy of digital interventions and we have seen that transformational innovations are able to impact the patient journey and disrupt the status quo. However, there remains significant potential to improve these outcomes through further innovation and new digital solutions.

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The challenge facing patients with 'Diabesity'

Chester Medical school shed light on the link between obesity and diabetes, the challenge facing patients with 'Diabesity' and the research contribution of the school in solving this problem

The UK has the highest prevalence of diabetes in the whole of Europe (with 3.7 million patients) and approximately 90% of these are Type 2 diabetes mellitus (T2DM). Approximately 90% of these T2DM patients are either overweight or obese, hence the term 'Diabesity'.

The link between diabetes and obesity

It is the chicken and the egg dilemma – does obesity cause diabetes or does diabetes cause obesity? Several pieces of evidence now suggest that obesity is one of the causes of the loss of insulin resistance that is characteristic of T2DM.

The first type of evidence is linked directly to fat metabolism. As we store fat, more specifically abdominal fat, our bodies enter a chronic inflammatory condition, particularly when the percentage of body fats exceed 30%. At this point body fat turns to 'angry fat' and starts to release several inflammatory cytokines and hormones. These inflammatory cytokines, for example, TNFα, inhibit glucose transporters and so reduce the sensitivity of our bodies to insulin.

Abdominal obesity, sometimes termed diabetogenic obesity, is reflected in the amount of fat stored in the cells of the pancreas. The β-cells in the pancreas are responsible for producing and releasing insulin into the blood, but this process is decreased as the pancreas stores fat. Thus, pancreatic fat inhibits insulin release and abdominal fat prevents cells from utilising glucose. These two actions result in insulin resistance and high blood sugar levels.

If T2DM is diagnosed before the impact of fat is permanent, it is possible to reverse this – i.e. by losing weight – either by diet or exercise, or both, then both insulin production and insulin sensitivity can be restored. So, curing T2DM is simple – weight loss and increase physical activity are the golden messages to prevent and control T2DM.

Why obese people with T2DM need to lose weight?

Clinical research and NICE obesity guidelines recommend 5-10% of weight loss in obese people with T2DM to decline HbA1c levels; to reduce the cardiovascular diseases (CVD) risk factors, and to limits the use of the anti-diabetic and anti-hypertension medications.

Why weight loss is challenging in people with T2DM?

Weight-loss can be difficult for people with existing T2DM for several reasons. Uncontrolled diabetes is associated with excessive hunger 'polyphagia' mainly because lack of insulin, or insulin resistance, maintains the glucose in the bloodstream rather than inside cells which means that tissues are unable to get the required energy for biological process and this increases hunger.

Several antidiabetic medications including, insulin, may promote weight gain because they have anabolic activities. Additionally, some antipsychotic medications that are used to treat the neuropathy associated with diabetes cause weight gain.

"The UK has the highest prevalence of diabetes in the whole of Europe (with 3.7 million patients) and approximately 90% of these are Type 2 diabetes mellitus (T2DM). Approximately 90% of these T2DM patients are either overweight or obese, hence the term 'Diabesity'."

Food restriction increases the production of a hunger-stimulating hormone 'Ghrelin' and it also reduces satiety hormones such as leptin.

Chester Medical School's role in tackling 'Diabesity'

Chester Medical School has a long-standing interest in the challenges facing patients with T2DM alone or combined with obesity. Professor John Williams, Associate Dean of the Faculty of Medicine, Dentistry and Life Sciences at the University of Chester says: "Chester Medical School has a significant research portfolio in biomedical and medical research, alongside its undergraduate and postgraduate programmes. We aim to utilise the expertise in the Medical School, to understand the mechanisms linking obesity, inflammation and Type 2 diabetes through research studies and to

inform practice through our taught MSc Diabetes".

> "If T2DM is diagnosed before the impact of fat is permanent, it is possible to reverse this – i.e. by losing weight – either by diet or exercise, or both, then both insulin production and insulin sensitivity can be restored. So, curing T2DM is simple – weight loss and increase physical activity are the golden messages to prevent and control T2DM."

Our long-standing research interest in heat shock proteins (HSPs) is being applied to diabetes research through the role of these in inflammatory reactions[1]. Previous research at Chester has found a novel beneficial role of folic acid (a form of vitamin B9) supplementation on reducing one of the stress proteins (HSP70) that indicates the severity of T2DM[2]. A European collaborative project found that step aerobics exercise combined with strength exercise for eight weeks showed a notable reduction in obesity markers[3].

Currently, Chester Medical School is adopting two main approaches to tackle the diabesity problem, the first approach is to conduct several studies to test the influence of nutritional and probiotic supplements on obesity and diabetes parameters. The second approach includes running an MSc Diabetes programme to engage medical school students from different professional backgrounds in evidence-based practice – in common with other Chester Medical School MSc programmes. This will embed research in the mind of healthcare professionals – always willing to engage with and propose, novel management strategies for diabesity.

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Chester Medical School | University of Chester

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Why Canada urgently needs a national strategy to tackle the diabetes epidemic

Kimberley Hanson, Director of Federal Affairs at Diabetes Canada argues that the country urgently needs a national strategy to tackle the diabetes epidemic

In Canada today, one in three Canadians lives with prediabetes or diabetes. In some communities that rate soars above 60%. Canadians under 20 years of age now face a 50% chance of developing the disease in their lifetime. For Indigenous Canadians, that risk is 80%.

If we continue with the status quo, the direct costs to our healthcare system will top $5 billion per year within a decade and the indirect costs will be triple that. And the human suffering involved is incalculable.

But first, a quick refresher on the disease: Diabetes is a metabolic disorder in which the body either cannot produce insulin or cannot properly use the insulin it produces. Insulin is a hormone that the body needs to use blood sugar as an energy source. The two main types of diabetes are Type 1 – an auto-immune condition that often develops in childhood – and Type 2, which occurs when the body doesn't make enough insulin or use properly that which it does make.

In addition, there's a precursor condition known as prediabetes, when blood glucose levels are higher than normal but not yet high enough to be diagnosed with Type 2 diabetes. Nearly 50% of those with prediabetes will go on to develop Type 2 diabetes if nothing is done.

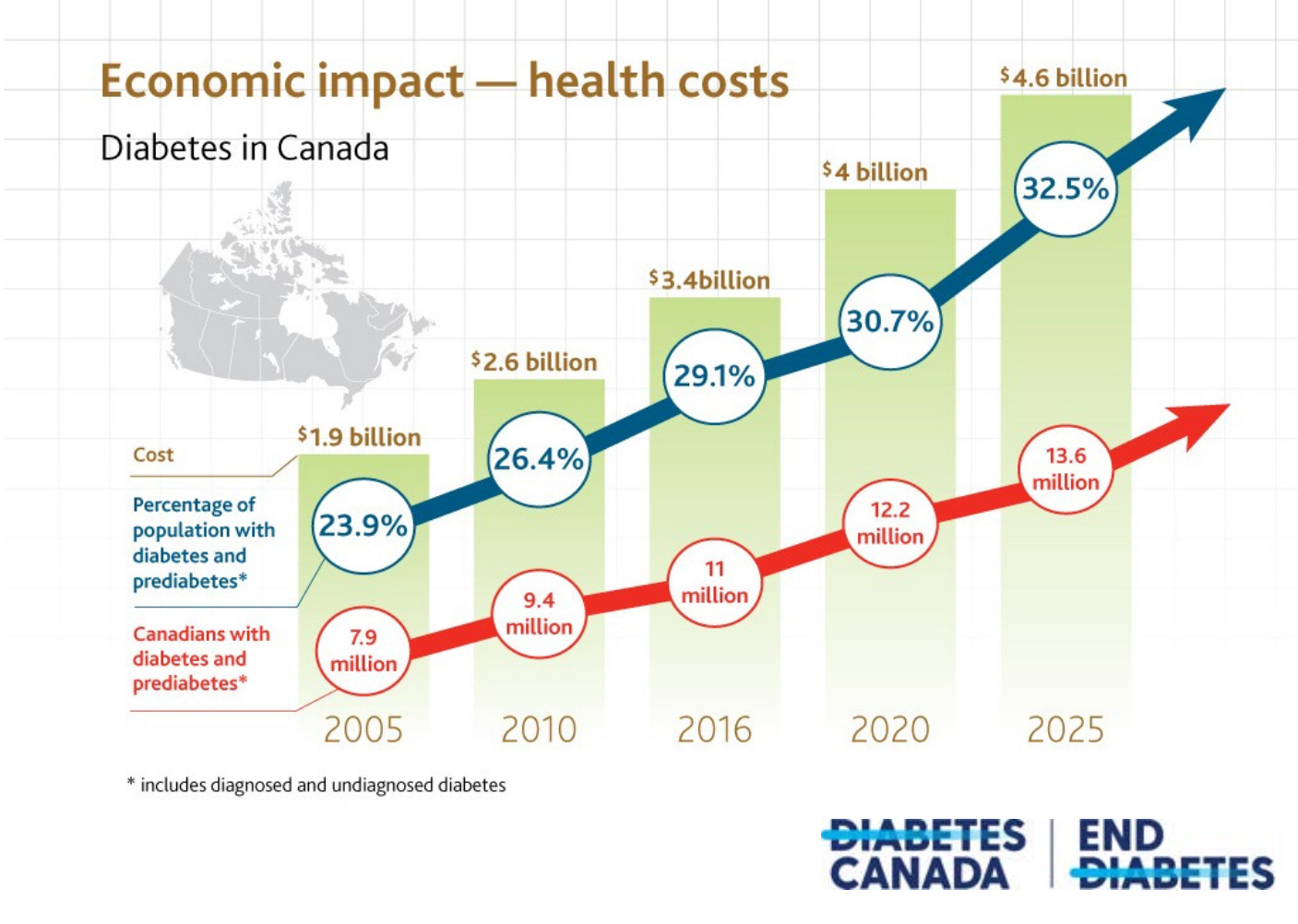
Diabetes can cause serious and life-threatening complications. People with diabetes account for 30% of the strokes, 40% of heart attacks, 50% of kidney failure requiring dialysis and 70% of amputations in Canada each year. The life expectancy of a person with diabetes is shortened by an average of 13 years. In 2012, the disease directly caused 1.5 million deaths worldwide and elevated blood glucose levels linked to diabetes were responsible for an additional 2.2 million deaths that year.

Alarmingly, diabetes is on the rise the world over and Canada is faring worse than many OECD (Organization for Economic Co-operation and Development) countries. Globally, the number of adults living with diabetes has quadrupled since 1980, from just over 100 million to more than 400 million according to the World Health Organization. The International Diabetes Federation lists Canada in the bottom third of OECD countries for diabetes prevalence. Diabetes or prediabetes now affect 11 million of the 33 million Canadians and yet, millions still don't know they have it.

It's time for an urgent change. This is not an epidemic that will be addressed by personal willpower and shame. To blame and stigmatise those living with Type 2 diabetes for their disease is not only unhelpful, it is a vast oversimplification. Type 2 diabetes is caused by a complex array of factors including genetics, lifestyle and environmental factors such as poverty, reduced access to clean drinking water, food insecurity and a disease-promoting food and physical environment. Issues of health inequality are at the core of the diabetes epidemic and addressing this epidemic is wholly reliant on addressing health inequities.

To really turn the tide of the diabetes tsunami, we need a nation-wide approach and in 2018, Diabetes Canada is developing just that. We're building on a successful "90-90-90" model implemented in the global HIV/AIDS community and adapting it to tackle diabetes in Canada.

Implementing such an approach would mean that, in time, 100% of Canadians would live in an environment that does not promote the development of diabetes; 90% of Canadians would know whether they're at risk of, or living with, diabetes; 90% of those with prediabetes or diabetes would be engaged in appropriate



treatment and support to avoid developing diabetes or its complications and, in consequence, 90% of them would be achieving improved health outcomes.

We know from research that when someone with pre-diabetes who makes moderate lifestyle adjustments (losing 5-10% of their body weight, for example), they are 60% less likely to develop the disease. That could mean that if we increase risk awareness and then provide adequate support, we could help 3.5 million Canadians make meaningful changes to avoid or significantly delay developing diabetes.

A coordinated approach to diabetes could translate into preventing diabetes in millions of Canadians who are currently on track to develop it. Millions of Canadians with diabetes who are at risk of developing serious complications like blindness, kidney failure or amputation would see that risk reduced. And significant time and money would be saved or used more efficiently by our health-care system.

Desmond Tutu once said: "There comes a point where we need to stop just pulling people out of the river. We need to go upstream and find out why they're falling in." When it comes to the millions upon millions of Canadians who already have or are well on their way to developing diabetes and its many complications, the time to move upstream and fix the problem is now. With guidance and input from hundreds of experts, in 2018 Diabetes Canada plans to chart a path to doing just that. ■

DIABETES CANADA | END DIABETES

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Addressing the shortage of diabetes specialist nurses

Over three and a half million people in the UK are currently living with diabetes, and as that number continues to increase, the role of the diabetes specialist nurse (DSN) is becoming increasingly important. Swansea University Medical School is responding to this training gap with an innovative new distance learning master's course

The latest Diabetes UK Workforce Survey (2016) highlighted that DSN workload has increased in volume and complexity since the previous 2012 survey. However, almost one-third of DSN posts have been cut or downgraded, or many left unfilled due to recruitment difficulties. The survey also uncovered that 57% of current DSNs will be eligible for retirement within the next 10 years.

Currently, training for DSNs is vocational, however, due to a lack of support to attain the qualifications and the experience necessary to progress and without succession planning, there will be no continuity of training for future DSNs. With the advancements in treatments and technology for diabetes, education for healthcare professionals (HCP) throughout primary and secondary care is required.

Swansea University Medical School has responded to this DSN training gap with the development of a new master's programme.

The unique, modular distance learning programme has been developed jointly by Dr Rebecca Thomas and Dr Sarah Prior at Swansea University Medical School and is led by Professor Stephen Bain. Both have vast experience in diabetes research, postgraduate education.

Dr Rebecca Thomas says: "The challenge of the recruitment, retention and training of diabetes specialist nurses (DSNs) was highlighted at a recent All Party Parliamentary Group (APPG) for Diabetes last year."

"The DSN role is vital for people with diabetes and DSNs have been facing overwhelming challenges. The workforce is getting smaller while the demand and case complexity is getting bigger."

The MSc Diabetes Practice has been specifically designed for healthcare professionals – particularly current or future DSNs – wanting to specialise in the field of diabetes. This is a modular distance learning course, offering HCPs the opportunity to graduate with an MSc Diabetes Practice Postgraduate degree studying full or part-time. The curriculum is multidisciplinary in nature, reflecting the integrated management processes within diabetes. The course not only includes specialised training, diagnostic and assessment-based knowledge but also encompasses personal and professional development, reflective practice and problem-based learning.

Dr Partha Kar, Consultant Diabetologist at Portsmouth NHS trust says: "Diabetes specialist nurses (DSN) are a vital part of the multidisciplinary team – perhaps even the lynchpin of diabetes specialist teams. Part of the £40 million NHS England diabetes transformation funds has been spent on increasing the number of DSNs. However, currently, there is no standard qualification for DSNs, making it difficult for people living with diabetes to know the level of expertise their nurses have.

Swansea University Medical School's Dr Rebecca Thomas and Dr Sarah Prior

"In order to improve outcomes, it is important that the diabetes multidisciplinary team ensures their knowledge and skills keep up with the latest advancements in therapies and technology in order to best meet the needs of their patients."

Dr Sarah Prior, Programme Co-Director, explains: "We have designed the programme to fit around the lives of busy health professionals – as well as being offered as an online distance learning course, we can also offer the option of part-time Master's, Postgraduate Diplomas and Postgraduate Certificates and individual CPD modules. There are also many funding options including bursaries, postgraduate loans and medical school scholarships."

Nicola Hewer is a DSN at Cwm Taf University Health Board. She is starting the MSc in Diabetes Practice in September. She says: "As a Community Diabetes Specialist Nurse working for a large Welsh NHS Trust, I face various complex care challenges on a daily basis. My job is very diverse and has both educational and clinical components to it. The number and complexity of people with diabetes is increasing, and I feel that the MSc in Diabetes Practice at Swansea University Medical School will help ensure I am fully equipped to effectively deal with any given situation.

"This course is of particular interest to me as it will allow me to study in my own time to fit in with my busy family and work life. Another plus is that I can choose to do a work-based portfolio, rather than writing another dissertation. I am really looking forward to starting the course in September and am particularly excited about meeting up with other specialists in this field to share best practice during the two residential weeks."

To find out more about the MSc in Diabetes Practice at Swansea University Medical School email:
study@swansea.ac.uk **or call +44 (0)1792 602 741.**

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- Insulin initiation – Type 2 diabetes
- Continuation of insulin – Type 2 diabetes
- Advanced insulin management – changing insulin
- Pump therapy – basics
- Poster presentations

Evening symposiums with expert speakers:

- Tuesday 12th February – speakers Prof Steve Bain and Julie Lewis
- Thursday 14th February – speaker Dr Partha Kar

Diabetes Management II
27th-31st January 2020

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- Continuous Glucose Monitors
- Flash Glucose Monitors
- Artificial Pancreas – looping
- Use of technology in Pregnancy
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Type 2 diabetes in the UK: Priorities for improving patient care

Professor John Wilding from the University of Liverpool charts priorities for improving patient care in the UK when it comes to the prevalent condition, Type 2 diabetes

In the last 30-40 years, we have seen a massive increase in the prevalence of diabetes. Today, more than 1 in 20 people, or 6.7% of the population, in the UK have Type 2 diabetes, increasing from just 1-2% 30 years ago.[1] Type 2 diabetes is a long-term metabolic disorder where blood glucose becomes too high due to a resistance to, combined with a failure of the pancreas to make enough of, the hormone insulin.

Over a long period of time, high levels of glucose can result in tissue damage to blood vessels and nerves, leading to an increased risk of heart attacks, strokes, amputations, eye damage and kidney failure. This is a very complex disorder, which affects a large number of people across the UK and poses serious challenges for both patients and clinicians. Its impact affects people's day to day lives and consumes approximately 10% of total NHS expenditure, with the majority of that money being spent on treating complications of the disease as opposed to the disorder itself.[2]

Despite its complexity, Type 2 diabetes is a manageable disease with a wide range of treatment options and effective management models within the UK. However, some key issues continue to affect the consistency with which the condition is managed. For example, the intricacy of treatment regimens can mean that people with diabetes are often taking so many different medications, at different times and for a variety of reasons, that it is incredibly difficult to ensure appropriate and consistent adherence. This can result in poor control of Type 2 diabetes risk factors, such as blood pressure and cholesterol, in addition to their blood glucose levels, leading to life-impacting complications, at a huge cost to the health system.

Education of people with diabetes about their condition and support for effective lifestyle interventions is also inconsistent, with some excellent models of care in some areas, but with patchy availability and uptake elsewhere.

Access to new medicines is another key issue for ensuring consistent care in diabetes management. While there are exciting new medicines available and more in development that have the potential to reduce the polypharmacy associated with this disorder, as well as reducing complications, many patients don't have access to these cutting-edge treatments. And with delays in access, we often also see a time gap between the evidence showing the efficacy of these medicines and the guidelines that recommend their use.

These challenges in managing Type 2 diabetes are long-standing, but there are ways in which we can tackle these current inconsistencies and improve care. Firstly, ensuring clinicians have the relevant education and skills to support their patients, will result in more effective diabetes management without increasing the burden on time-poor health services. Given around 4 million people currently have Type 2 diabetes, it would be impossible for all patients to have regular contact with secondary care specialists. As a result, the majority of diabetes care is delivered by GPs and practice nurses.

Providing primary care professionals with the necessary training and support to deal with Type 2 diabetes is vital, as a lack of knowledge can mean they are reluctant to start and escalate therapies, which can more adequately maintain control of blood glucose levels. These delays in switching patients to the most effective treatment can mean that people with Type 2 diabetes are at a greater risk of developing complications, therefore, decreasing their quality of life and increasing the pressure on local health services.[3]

Secondly, more efficient use of resources and time can result in better care and cost savings. The introduction of Regional Medicine Optimisation Committees (RMOCs) and Sustainability and Transformation Partnerships (STPs) into the NHS will be key in influencing the change in diabetes management across the UK. By using these platforms to encourage more joined-up working across health services, learnings from areas of the UK where we have already seen improvements through high-quality diabetes management can be shared and lead to a greater level of consistency in care across the country.

Finally, taking a long-term view of budget planning could have a huge impact on managing the increase in the prevalence of Type 2 diabetes. Currently, health service budgets are reviewed year on year, making it difficult to see where changes to current care practices have created efficiencies and reduced costs. Investing money now in education and support, to address the challenges we currently face, could result in greater cost savings later.

We need to prioritise simple solutions, which are easy to implement. Education and training for both patients and healthcare professionals is a key way that we can do this and will result in better management of Type 2 diabetes and ultimately, cost savings to the health system. ■

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Diabetes: A paradigm case for rewarding innovation in value-based healthcare

Prof Dr Freimut Schliess, Director of Science & Innovation at Profil Institut für Stoffwechselforschung GmbH explains the important role of innovation when it comes to healthy living and active ageing, including his thoughts on the diabetes paradigm

The International Diabetes Federation estimates that 66 million people have diabetes in Europe – with a rising trend towards 81 million people by 2048. Diabetes is a hub for co-morbid conditions and triggers frailty, pre-mature ageing and death from any cause. Today a woman who becomes diagnosed with diabetes at the age of 50 will lose almost seven years of her life, owing to diabetes.

Societal investments in healthy living and active ageing are key when aiming at reducing the relative risk of premature mortality from major chronic diseases by 25% before 2025 (as declared by the WHO) and increasing healthy lifespans by two years by 2020 (as envisioned by the European Innovation Partnership on Active and Healthy Ageing). The European Institute for Innovation and Technology (EIT) has recently implemented the EIT Health Knowledge and Innovation Community – a public-private partnership specifically dedicated to accelerating entrepreneurship and innovation for healthy living and active ageing in Europe.

Diabetes provides lots of room for rewarding innovations in healthy living and active ageing: the most important disease trigger is highly modifiable, pathogenetic transitions are potentially reversible and self-management plays an outstanding role in diabetes management. Therefore, one obvious strategy to prioritise investments in healthy living and active ageing would be to focus on the prevention and management of diabetes. This would have a profound effect on the overall chronic disease burden and be particularly effective in promoting healthy living and active ageing in Europe.

A life and disease course approach to diabetes

Following a combined life- and disease course approach may help to fully exploit the potential of innovations in diabetes (see the Figure): innovations in health promotion, diabetes prevention and diabetes management should be adjusted to the peoples socio-cultural and socio-economic background, as well as to biological signatures, the functional status and self-perception of health-related quality of life. In older age, adding quality of life to the amount of life and function to chronic disease may become an increasing priority. We suggest a strong commitment with the EMA geriatric medicines strategy, highlighting the specific needs of elderly people.

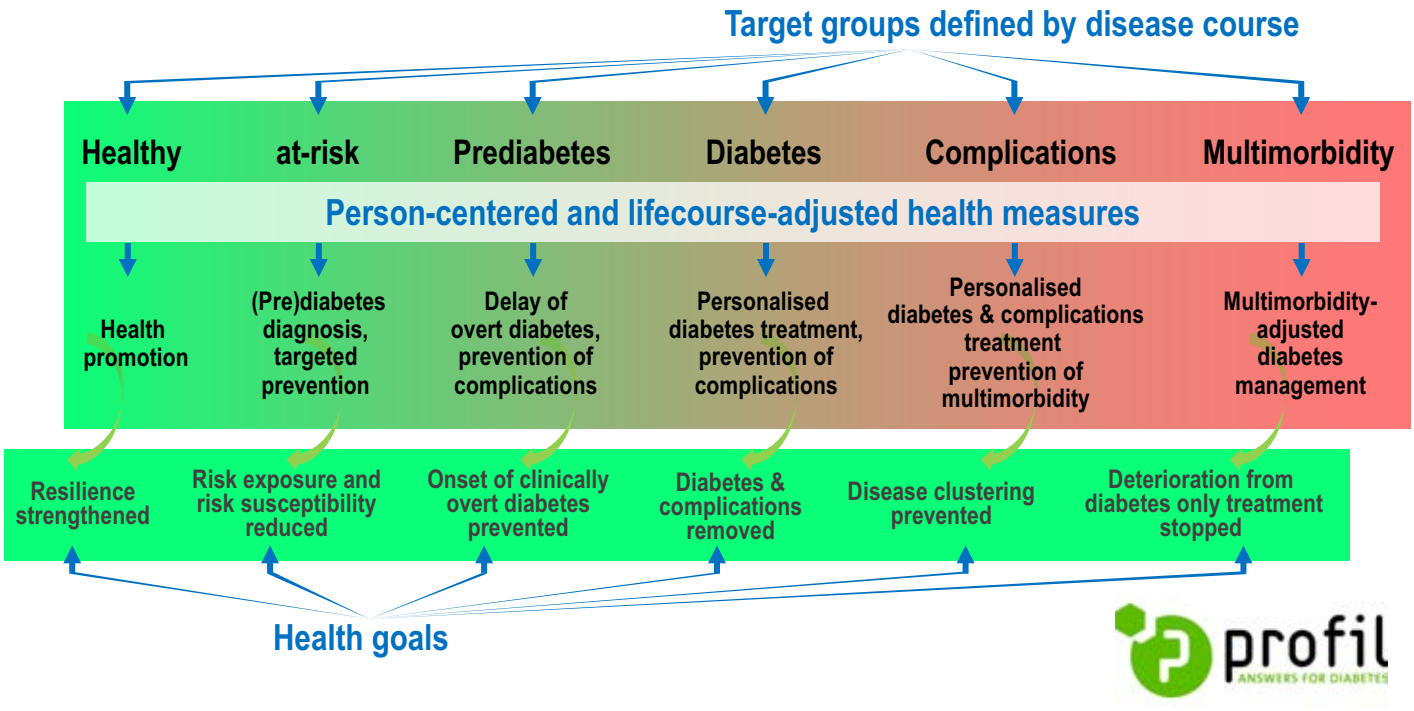
People-centred health promotion

Challenges. European living and working environments are obesogenic. They inherently pose disease risks by promoting physical immobility and unhealthy food choices. Education on how to prevent frailty and disability at an older age is underdeveloped. There is a gap between available knowledge and public awareness of disease-promoting behaviour.

Space for innovations. Policies for implementing anti-obesogenic living environments are needed. Housing design should support a long-lasting preservation of personal autonomy and societal participation. Health promotion at work has the potential to reach a large part of the population, but strategies for improving the sustainability of worksite health promotion measures are needed. A clear labelling of processed food products should indicate the health risk imposed by them. Healthy food choices should be facilitated by responsible food advertising and presentation. Products and services integrating social media, tele-coaching and the Internet of Things (IoT) and services could be tailored for specific target groups and allow for a benchmarking with peer groups. There are challenges to be overcome in regard to scalability, interoperability and privacy protection.

Person-centred diabetes prevention

Challenges. Glucocentrism does not meet the entire complexity of diabetes and inherently limits the efficacy of current diabetes prevention. Available



Definition of target groups and corresponding health goals by diabetes course. With increasing age (another dimension) the preservation and rehabilitation of functional capabilities gain in importance for health goal achievement.

tools do not effectively differentiate between metabolically healthy obese and obese people at risk. They identify neither lean, but metabolically obese people, nor people with sarcopenic obesity. Also, tools specifically addressing the frailty and morbidity risk of the elderly are not yet established. Lifestyle interventions appear to be inefficient outside of clinical trials.

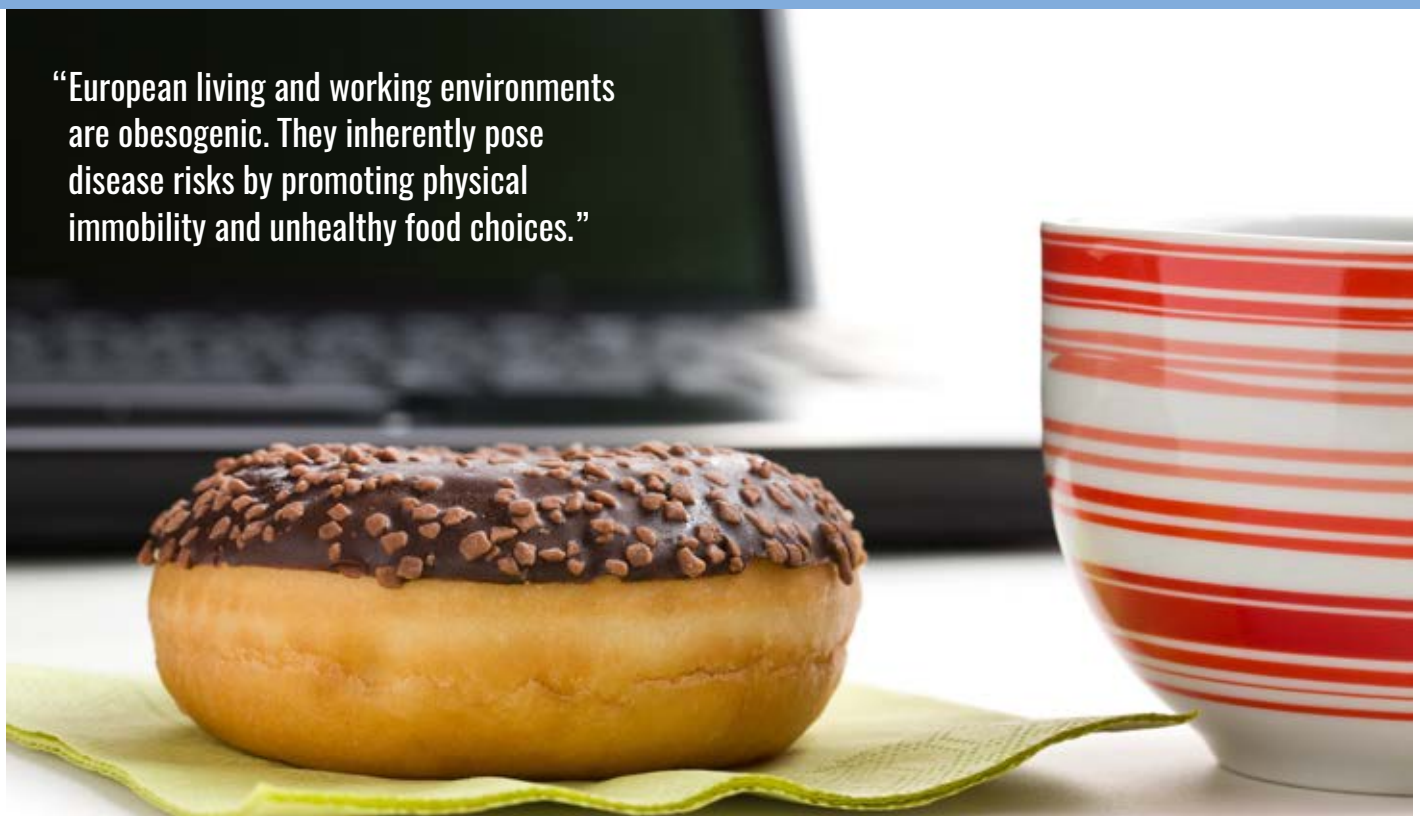
Space for innovations. The overarching goal of new tools and services for preventing diabetes should be to stop the progressive loss of beta cell function. Interception with pro-diabetic transitions much before glycaemic criteria of pre-diabetes are met, will be key to increasing the effectiveness of diabetes prevention. A pre-diabetes taxonomy, based on genetic and metabolic signatures, will improve our understanding of the diversity in (pre)diabetes traits. We need tools that replace a rigid allocation of people to chronological age groups by a classification referring to states of biological and functional ageing.

Also, a thorough consideration of individual life characteristics, goals and preferences will optimise the precision fit of diabetes prevention measures. Digital solutions providing specific feedback loops, based on the processing of individual health and behavioural data will help to reach and motivate relevant target groups, and to incentivise the achievement of individual health goals.

Patient-centred diabetes treatment and prevention of co-morbid conditions

Challenges. A curative therapy of diabetes preventing co-morbid conditions is still missing. Closing the loop between blood glucose assessments and insulin dosing still depends on patients' action. Particularly in the elderly, this accounts for extended periods of dysglycaemia that pose a considerable risk of frailty and physical (falls and fractures) and mental (cognitive impairment, dementia) disability. Many people with diabetes fail to reach their treatment goals – despite the plethora of therapeutic approaches that are available today.

Space for innovations. Sensor-based technologies for the collection of digital biomarkers and predictive algorithms may facilitate an early identification of patients with a high risk of co-morbid conditions. Drugs that protect beta cells from death and/or stimulate endogenous beta cell regeneration will greatly improve life quality and clinical outcome in people with diabetes. Future insulin sensitisers should refer to a full understanding of insulin resistance – particularly in the process of ageing. Artificial Pancreas systems will approach a "technical cure" of diabetes by mimicking the closed-loop metabolic control of blood glucose levels seen in healthy people. There is a trend towards integrating the prescription of drugs and devices within value-based schemes of chronic care provision, such as an integrated personalised diabetes management coupled to pay for performance compensation models.



Co-morbidity-adjusted diabetes management

Challenges. The top 10% of patients with Type 2 diabetes that incur the highest costs are likely to bear a high co-morbidity burden, to be on insulin therapy and to suffer from obesity and hypertension. Here, treatment guidelines focused on diabetes may conflict with co-morbid conditions, resulting in adverse interactions between drugs and diseases, non-compatible management strategies, polypharmacy and cost inefficiencies. In real-life conditions, treatment-effect-modifiers contribute to the well-known discrepancy between drug efficacy in clinical trials and drug effectiveness observed in everyday clinical practice.

Space for innovations. Improving the strength of primary care may immediately translate into lower rates of avoidable hospital admissions and fewer years of life owned to diabetes. Integrated personalised diabetes management programmes should pursue a proactive release of high-quality chronic care, focused on the outcome. The telemedical consulting centre will have a high potential to ensure high-quality care especially in areas of rural depopulation with a high proportion of old people, and a low density of diabetic care practices. Predictive models will become available that balance individual life expectancy against lag time to benefit from specific interventions, based on signatures of biological ageing, as well as the patient-specific shaping of functional impairment and co-morbid conditions. Tools are required predicting the interaction of drugs at the levels of pharmacokinetics, pharmacodynamics, as well as safety and tolerability.

Perspective

Although diabetes is a paradigm case for rewarding innovation in healthcare, open and collaborative knowledge and innovation communities such as EIT Health are needed to fully translate societal investments into a tangible impact for European citizens. The coordinated curation of innovation portfolios targeting healthy living and active ageing, as well as the elimination of general obstacles to innovation, can be achieved best in close interaction with societal stakeholders. An inherent integration of close-to-market research, education & training and the creation of new businesses (EIT knowledge triangle) will greatly support innovators in diabetes to make a triple impact – on the healthcare experience of individual patients, the health of populations, and the sustainability of healthcare systems.

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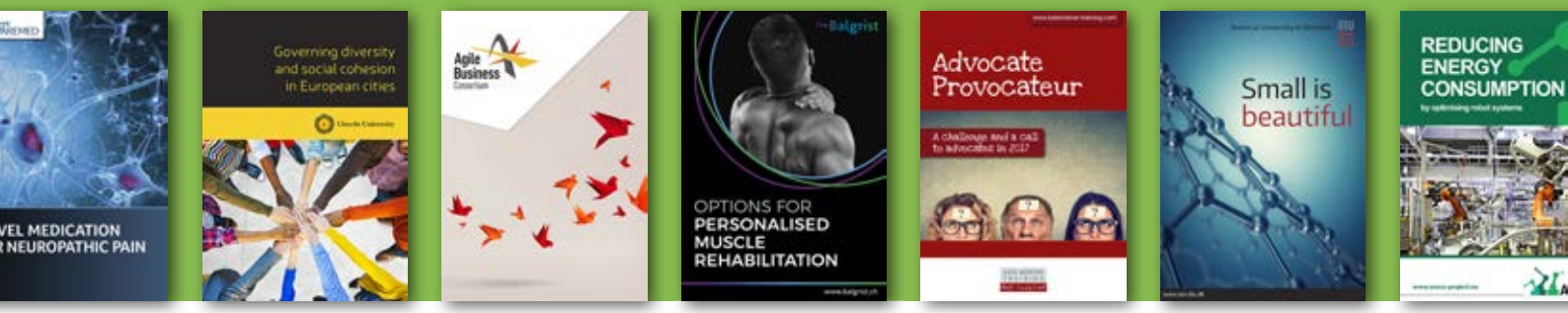

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The role of collaboration in tackling paediatric cancer

Prof. Martin Schrappe, President of the European Society for Paediatric Oncology details the vital role of collaboration in tackling paediatric cancer across Europe

Paediatric cancer is a rare disease that comes in multiple subtypes, represents both a life-threatening disease and a major public health issue. Each year, more than 6,000 children and young people die of cancer and 35,000 new cases are diagnosed. Despite improvements in the cure rates over the last decades, childhood cancer remains the leading cause of death in children above one year of age in Europe. Moreover, childhood cancer survivors may face long-term side effects that negatively affect their quality of life and participation in society.

Among the factors that define the policy and regulatory priorities for the paediatric cancer sector, are the rarity of individual paediatric cancer types, their dissimilarity from adult cancers and their high collective health burden across Europe.

Cross-border collaborative research is, therefore, vital to overcome small sample sizes at the national level and to foster scientific advancement towards more and better cure. The development of innovative therapies for children with cancer should require urgency since the medicines currently available are sometimes decades old, leading to stagnating cure rates and long-term sequelae. Another important orientation is cross-border access to the right expertise to ensure optimal treatment and follow up – and to address inequalities in survival rates across Europe.

Since 1998, the European Society for Paediatric Oncology (SIOP Europe or SIOPE) has been active on the European landscape, working closely with parents, patients and survivors to influence legislation and taking part in European-funded projects. In the process, the community has formulated and is currently implementing the SIOPE Strategic Plan with the goal of increasing the cure rate and the quality of cure for children and adolescents with cancer by the year 2025.

Prof. Martin Schrappe, President of SIOP Europe

Coordinated funding for clinical trial activities across borders is a key challenge. An important past EU project – ENCCA (European Network for Cancer Research in Children and Adolescents) – enabled the creation of the SIOPE Clinical Research Council, bringing together all clinical trial groups and national societies for paediatric haemato-oncology in Europe. Continuity is instrumental to build on the achieved results and SIOPE has been advocating for the next EU Framework Programme for Research and Innovation to further support stable and sustainable clinical trial platforms and international collaborations for paediatric haematology and oncology. In addition, SIOPE is closely monitoring the process leading up to the implementation of the EU Clinical Trials Regulation and has contributed to the legislative process.

Boosting access to innovative therapies for childhood cancer is vital. In 2007, the EU Paediatric Medicines Regulation was launched with the aim of meeting the specific therapeutic needs of children with better-evaluated and authorised medicines. However, whereas the adult cancer sector has seen a flurry of innovation over the past years, only very few new medicines have been authorised for cancer affecting children since 2007.

SIOPE Europe together with partners from the parents and patients' community are working with all stakeholders, including industry and regulatory agencies in the ACCELERATE platform, to improve the implementation of the EU paediatric medicines regulation and continue to advocate a series of targeted changes to accelerate the development of medicines for paediatric cancers. Specific proposals include running the paediatric strategy forums, jointly coordinated by ACCELERATE and the European Medicines Agency (EMA), to share information and advance learning in a pre-competitive setting, breaking the 18-years dogma for participation in clinical trials, FDA and EMA alignment, earlier submission of paediatric investigation plans and implementing development plans based on paediatric tumour biology and drugs' mechanism of action.

The poor diagnosis and treatment of childhood cancer is still a reality in certain cancer types and countries, with large disparities in access to standards of care and specialised interventions across Europe. The EU Directive on Cross-Border Healthcare has engendered the development of the European Reference Networks (ERNs), one of which is fully dedicated to childhood cancers (ERN PaedCan). This network has been instrumental in furthering the paediatric cancer agenda, making it possible to share expertise across Europe, thereby facilitating the lives of both healthcare providers and patients whose conditions require specialist expertise and tools not widely available due to low case volumes or lack of resources.

As the EU Commissioner for Health and Food Safety, Vytenis Andriukaitis has said: "no country alone has the knowledge and capacity to treat all rare and complex conditions".

ERN PaedCan aims to increase childhood cancer survival and quality of life in the long term, by fostering cooperation and training, with the ultimate goal of reducing current inequalities in childhood cancer survival and healthcare capabilities across the EU Member States. Virtual tumour boards provide quality assurance and are a cost-effective way to deliver guidance in paediatric cancer treatments. Sustainability of this new mechanism is vital to ensuring equal access to the best knowledge for all children and young people with cancer, no matter where they live in Europe.

Another area that calls for policymakers' attention is childhood cancer survivorship. The population of childhood cancer survivors in Europe is growing. These survivors are often faced with distinct and severe chronic health challenges throughout their lifespan. It will become increasingly important to put in place mutually agreed guidelines on the surveillance of childhood cancer survivors and the appropriate models of care.

Other orientations include the exploitation of e-health to underpin research, outcomes data collection and long-term health surveillance. Successful approaches in this field include multi-stakeholder dialogue and collaboration, as well as balancing data privacy and the need for research progress.

As it has become common knowledge that multidisciplinary collaboration in therapeutic research would make improvements in outcomes be possible, SIOP Europe continues furthering dialogue and cooperation with various EU actors to address the urgent needs of children and adolescents with cancer. Progress is only possible through joint efforts and an enabling legislative and regulatory environment that facilitates cross-border approaches and targets the priority areas identified jointly by professionals, parents, patients and survivors. The importance of collaboration between all relevant stakeholders in developing paediatric cancer therapies cannot be stated enough. ■

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The diagnosis and treatment of cancer in the United States

The vital work of the National Cancer Institute, part of the National Institutes of Health, is placed under the spotlight here by Open Access Government, including the dissemination of new findings on the diagnosis and treatment of cancer

The National Cancer Institute, part of the National Institutes of Health, is the U.S. federal government's lead agency in coordinating research, providing training and disseminating new findings on the diagnosis and treatment of cancer.

In 1937, President Franklin D Roosevelt signed the National Cancer Act to support cancer research – the first time Congress had appropriated funds for a non-communicable disease.

The act established the National Cancer Institute as the federal government's primary agency in coordinating grant funding for cancer research, providing training in diagnosis and treatment and disseminating the findings of research carried out in the U.S. and other countries.

Thirty-four years later, the National Cancer Act of 1971 greatly expanded the role of the NCI, giving its director the broad authority to plan and develop an intensified and coordinated National Cancer Programme that included NCI and related initiatives, other research institutes, federal and non-federal programmes "in order to more effectively carry out the national effort against cancer".

The act also granted the NCI director access to the president of the United States and required them to submit an annual budget directly to the Oval Office. Furthermore, it established the National Cancer Advisory Board, made up of 18 distinguished scientists, members of the public and ex-officio members of other government agencies, to advise the NCI on its programmes, along with the President's Cancer Panel to provide annual reports.

On top of this, the act provided additional funding to establish 15 new cancer research centres, local control programmes and an international cancer research data bank.

Over the years, the NCI has established several major programmes to tackle cancer, including the Cancer Information Service (1976), the Office of Cancer Survivorship (1996) to study ways to enhance the length and quality of life for cancer survivors and the TARGET Initiative (2006) to identify the molecular characteristics of childhood cancers in order to design better treatments.

It has also worked with the National Human Genome Institute to launch the Cancer Genome Atlas, a project to systematically examine the genomic changes involved in human cancer.

There has been tremendous progress made. Over the past two decades, research has led to a 25% decline in the rate of deaths from cancer.

However, there is still much to do. Nearly 40% of Americans will be diagnosed with cancer in their lifetimes. Around 600,000 adults and 2,000 children die from cancer in the US every year.

The NCI is pushing ahead with a broad portfolio of research. In 2017-18, the institute's total budget stood at $5.67 billion, around 40% of which goes towards research grants.

Current key initiatives include the Cancer Moonshot, an ambitious plan to accelerate a decade's worth of

research into five years through targeted grant funding, supplements and where appropriate, partnerships with foundations, academia and the private sector. In 2016, Congress approved $1.8 billion over seven years to support the Cancer Moonshot.

The NCI also runs the Precision Medicine Initiative, which focuses on four broad areas – new and expanded precision medicine clinical trials; overcoming drug resistance to cancer treatments; developing new laboratory models for cancer research; and building and sharing a digital repository of data resulting from NCI-sponsored precision medicine clinical trials – with the aim of bringing precision medicine into everyday clinical practice.

Meanwhile, the National Clinical Trials Network (NCTN), the cornerstone of NCI's clinical trials programme, brings together organisations and clinicians to conduct large-scale trials across the U.S. and Canada. These help to establish new standards of care, move new therapies toward FDA approval, test new approaches to radiation therapy and surgery and validate new biomarkers. The NCTN provides the infrastructure for NCI-funded treatment, screening and diagnosis treatments at over 3,000 sites.

NCI-backed research has made headlines in recent months. In June, it was reported that a novel approach to immunotherapy developed by NCI researchers had led to the complete regression of breast cancer in a patient who had been unresponsive to all other treatments.

> "Nearly 40% of Americans will be diagnosed with cancer in their lifetimes. Around 600,000 adults and 2,000 children die from cancer in the US every year."

The findings of the clinical trial, which was led by Dr Stephen A Rosenberg, chief of the surgery branch at the NCI's Center for Cancer Research, were published in Nature Medicine.

"We've developed a high-throughput method to identify mutations present in a cancer that are recognised by the immune system," Dr Rosenberg says.

"This research is experimental right now. But because this new approach to immunotherapy is dependent on mutations, not on cancer type, it is in a sense a blueprint we can use for the treatment of many types of cancer.

"All cancers have mutations, and that's what we're attacking with this immunotherapy. It is ironic that the very mutations that cause the cancer may prove to be the best targets to treat the cancer."

The Center for Cancer Research is the largest division of the NCI intramural research programme and comprises nearly 250 groups conducting basic, translational and clinical research. The CCR's clinical programme is housed at the National Institutes of Health's Clinical Center, the world's largest hospital dedicated to clinical research. ■

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Cancer immunotherapy therapy is here and now

Stephanie K. Watkins PhD from Loyola University Chicago shares her views on cancer immunotherapy therapy – the concept of using the immune system to fight and destroy cancer cells

The concept of using the immune system to fight and destroy cancer cells has been a dream of clinicians since 1891 when Dr William Coley first injected a patient with an inoperable bone cancer with streptococcal organisms and observed the regression of an aggressive, malignant tumour. These first attempts were quite extraordinary, given how little was known or understood about the immune system at that time. Unfortunately, because of this lack of understanding, many clinicians ignored the potential that these immune therapies carried to cure cancer and the strategy fell by the wayside for many years.

Now that the field of immunology has exploded and is accepted as a critical component across all areas of medicine, scientists and clinicians are once again focused on utilising the power of the immune system to eradicate cancers of all origins. Immunotherapies today are highly technologically advanced and target an array of properties of the immune system. In this review, we will briefly cover the main types of therapy used in the clinic.

Monoclonal antibodies are one class of immune therapies designed to target specific antigen (Ag) expressed by tumour cells. Different types of monoclonal antibodies include: naked, conjugated and bispecific. The naked monoclonal antibodies consist of popular drugs, such as alemtuzumab, trastuzumab and pembrolizumab. The naked monoclonal antibody sticks to the target Ag on the surface of tumour cells and generates an immune response by recruiting immune cells to destroy the cell harbouring the antibody. A second mechanism uses the antibody to block Ags on cells in the tumour microenvironment.

> "The major advantage of immune-based therapies is that they are very individualised for each patient and tailored to "natural" protection against tumours."

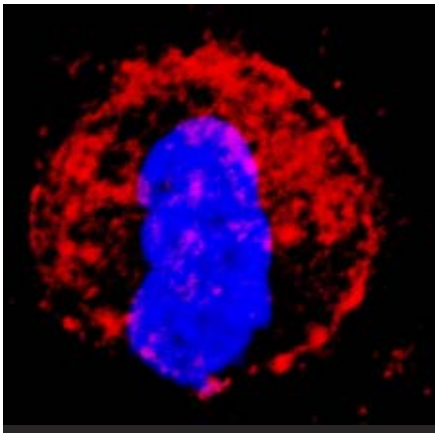
The blockage prevents tumours from growing or spreading by denying activation of the blocked Ag. The conjugated monoclonal antibodies are joined to a chemotherapy drug or sometimes a radioactive particle. This type of monoclonal antibody is often used to deliver a cytotoxic drug (the chemotherapy or radioisotope agent) directly to a tumour cell that is bearing the target antigen. The directed delivery lessens the destruction of normal healthy cells during the destruction of tumour cells.

The bispecific monoclonal antibodies are drugs designed to target two different antigens, one on the tumour cell and one on the T cell, an immune cell capable of killing tumour cells and the antibody brings the two cells together, allowing the T cell to destroy the cancer cell. The largest hurdle to overcome with monoclonal antibody therapy is that cancer cells constantly mutate or lose expression of the antigen – that antibody was designed to target and frequently become resistant to the therapy. Therefore, the key to this therapy is choosing the appropriate target and monitoring desensitisation.

Similar to monoclonal antibody strategies, one of the most successful therapies across a spectrum of cancers currently, is the use of immune checkpoint inhibitors. T lymphocytes or T cells are a critical cell in the immune system and are the primary cell responsible for targeting and destroying cells that are harmful to the body, including virus-infected cells and tumour cells. In normal immune responses, it is important to keep T cells under control and prevent them from destroying healthy tissues, therefore, when they are activated they upregulate receptors on the cell surface that allows their functions to be quickly turned subdued. These regulatory receptors include PD-1 and CTLA-4.

In cancer, when activated T cells infiltrate a tumour, many tumours express the ligands that bind to the regulatory receptors and can turn T cells "off". Therefore, the checkpoint inhibitors are designed to bind to either the receptors or the ligand and prevent the interaction from eliminating the T cells anti-tumour functions.

Commonly used drugs are the PD-1



Dendritic cell coated with prostate specific antigen

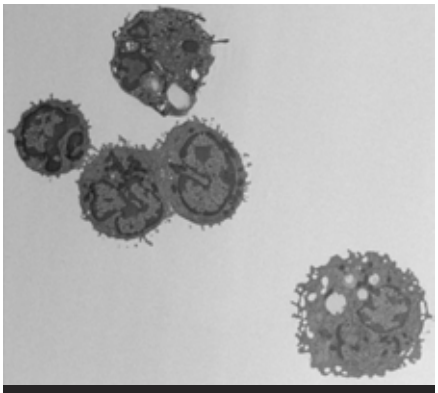
inhibitors pembrolizumab and nivolumab, PD-L1 inhibitors atezolizumab, avelumab and durvalumab and CTLA-4 inhibitor ipilimumab. Ipilimumab was the first FDA approved immune-checkpoint drug for the treatment of melanoma and kidney cancers. Within the last year, six more drugs in this class have made approval and the list continues to grow. Current strategies are now working to combine these checkpoint inhibitors with the use of small molecule drugs that can also prevent T cell exhaustion, which happens in during chronic antigen stimulation, such as within a tumour.

> "Now that the field of immunology has exploded and is accepted as a critical component across all areas of medicine, scientists and clinicians are once again focused on utilising the power of the immune system to eradicate cancers of all origins."

The third class of therapies making tremendous strides in the clinic today are the cancer vaccines or adoptive T cell transfer therapies. This therapy is the direct transfer of immune cells into a patient that is capable of either directly destroying cancer cells or boosting the internal immune response to fight cancer. The first vaccine of this type was called sipuleucel-T (Provenge) and was approved by the FDA in 2010 for the treatment of metastatic prostate cancer. Provenge was a vaccine using dendritic cells (DC). DC is responsible for presenting antigen to T cells that are then stimulated to attack cancer cells bearing similar antigen. The original trial was conducted in 512 randomised patients and the vaccine was found to extend the median survival time 4.1 months. Again, this was a small but important step, paving the way for more advanced immune cell vaccines.

In recent years, researchers have identified ways to make more effective and potent immune cells for patient delivery. The CAR T-cell therapy was FDA approved for treatment of children with acute lymphoblastic leukaemia (ALL) and adults with other lymphomas in 2017. CAR T-cell stands for chimeric antigen receptor T cell. These T cells are the patient's own T cells that are genetically modified to add an artificial receptor to their cell surface that targets the CD-19 molecule by cancer cells. The genetic modifications promote the T cell to produce an abundance of inflammatory proteins, called cytokines and often resulting in a "cytokine storm" shortly after patient administration. It's approximated that 70-90% of patient experience this short-term event due to the robust immune response. Originally, the cytokine storm was somewhat feared as a negative result of stimulating the immune system, but now with drugs, such as tocilizumab, the duration and intensity can be controlled, and the cytokine storm may be observed as a positive event indicating the initiation of an effective therapy.

The major advantage of immune-based therapies is that they are very



Electron microscopy image of immune cells, T cell, neutrophil, monocytes

individualised for each patient and tailored to "natural" protection against tumours. Many immune bases therapies, especially the adoptive T cell transfer therapies consist of a single infusion with only a few weeks of follow up care, compared to traditional chemotherapy approaches which often last six months or more. Cancer continues to evolve, but research and ongoing clinical trials are making successful strides to employ new technologies to harness the power of nature's best medicine, the immune system.

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The challenge of curing cancer in the world's children

Dr Martin English, Consultant Paediatric Oncologist and member of the Royal College of Paediatrics and Child Health (RCPCH) explains the challenge of curing cancer in the world's children

The outcome of treatment for children's cancer isn't good enough. Yes, it is one of the success stories of medicine over the past 50 years, but there is more to do. Today over 80% of those diagnosed with cancer in Western Countries before their fifteenth birthday will be cured. But in a cruel twist of the 80:20 rule, four in five of the world's children with cancer don't even get adequate pain relief, never mind the chance of cure.

But I'm a paediatric oncologist, so my glass is half full. Let's SWOT childhood cancer from two directions. The rich and the poor.

Our strength is we are already four-fifths of the way to cure. Curing cancer in children requires access to chemotherapy, specialised surgery, and radiotherapy. Some cancers can be cured with one modality alone, such as chemotherapy for the commonest form of cancer, acute lymphoblastic leukaemia (ALL), or surgery to remove an eye affected by retinoblastoma – a cancer occurring in the first few years of life. Others require a complex integration of all three modalities.

> "Cancer is the commonest cause of death in childhood in the West, but through great efforts, death rates continue to fall even when other causes of death such as accidents and infection are also causing less mortality."

The successes enjoyed in the West can be reaped more quickly in the developing world. The organisation of services starts with basic immunisation to improve immunity and general health. It moves on to safe access

to blood product supplies and the availability of CT and MR scans. Access to specialist surgery, intensive care and radiotherapy is also necessary. These all need to be available not as stand-alone services, but as integrated multi-disciplinary teams to provide seamless care.

Globally, the biggest weakness is the cost of care to families. The treatment of a child with cancer is expensive. But even if care itself is free and relatively simple, the cost of one parent having to stay with the sick child in a hospital and the other possibly having to stop work to look after siblings makes treatment abandonment a major problem in the developing world. In Western countries, the stark choice of treating one child, but letting your others starve is not there because of social security systems. However, there may still be a major impact on a family's income if there is one child with a chronic illness and one or both parents must give up work. Malignancy in a child is one reason for families to slip below the poverty line.

In the West, we have opportunities to try and cure the one in five children who currently die. There is a whole new treatment paradigm developing for cancer generally using manipulations of the immune system, such as CAR T-cell therapy and treatment that blocks the pathways cancer cells use to grow out of control. However, therapies that may work in adults may have unacceptable problems in children. For example, the treatment that blocks the Sonic Hedgehog Pathway (yes, that really is what it is called) in cancer may also cause the growth plates in the limbs and spine to fuse with the result that a child stops growing and ends up as a very short adult if their tumour is cured.

Cancer is the commonest cause of death in childhood in the West, but through great efforts, death rates continue to fall even when other causes of death such as accidents and infection are also causing less mortality. In the poorest countries, simply improving health care systems to provide basic nutrition, immunisation, primary and secondary healthcare will create a situation where it is possible for some children to be cured with simple surgical interventions, such as for the eye cancer retinoblastoma.

We know that 50% of children with acute lymphoblastic leukaemia can be cured with what is now regarded as a relatively gentle out-patient based treatment over two to three years and once there are basic health care infrastructures in place that can be provided relatively simply throughout the world, then these children can be cured in resource-limited settings. In the developed world, over 90% of children with ALL are cured by significantly more intensive treatments. If we could identify the half who are cured with simpler regimes, we could save significant costs and reduce the burden of treatment on children and families.

Finally, what are the threats? In the developed world more and more is spent on diminishing returns. Part of the art of paediatric oncology is recognising when further treatment is futile and attempts at cure may result in unnecessary suffering. The biggest returns globally will be in middle-income countries, where organising services already available can quickly move survival rates from well under to over 50%.

And finally, a cure does come at a cost. Survivors of childhood cancer are more likely to have chronic health conditions than others and as numbers increase, appropriate long-term health care needs to be available to reduce later ill health.

To sum up, we are winning the battle, but there is still a long way to go before we win the war against childhood cancer. ■

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Elucidating the pathogenesis of paediatric cancers

Prof Nicolo Riggi, Prof Ivan Stamenkovic and Prof Ivan Stamenkovic from the University of Lausanne share their thoughts on the pathogenesis of paediatric cancers

Paediatric malignancies differ from adult cancers in both their pathogenesis and behaviour, largely due to their distinct genetic and epigenetic underpinnings. In contrast to the majority of adult cancers, which develop years to decades following transformation of a single cell, paediatric cancers, particularly those that occur in the first few years following birth, emerge far more rapidly. Whereas most adult cancers accumulate a multitude of genetic mutations by the time they become clinically detectable, the majority of paediatric cancers are genetically "quiescent", meaning that they harbour few and sometimes even only single mutations.

Numerous mutations can contribute to adult cancer growth and different mutations may drive the progression of any given cancer at different stages of its evolution. Determining which mutation(s) is/are driving an adult cancer at the time of diagnosis can, therefore, be challenging. In contrast, mutations responsible for paediatric cancer development are easier to identify, which facilitates exploring the pathogenesis of these tumours and obtaining clues as to potential therapeutic targets and options.

Although genetic mutations have long been thought to play the key role in the pathogenesis of cancer, it is becoming increasingly clear that in many malignancies, posttranslational and epigenetic modifications may play an equally important role, sometimes even dominating that of the genetic mutations. "Epigenetics" was originally coined to describe heritable changes in a cellular phenotype that were not due to alterations in DNA sequence. It is most commonly used to describe chromatin-based events that regulate DNA-templated processes such as gene expression.

Chemical modifications, such as methylation of DNA within gene promoters and of acetylation and methylation of histones, which are proteins intimately associated with DNA, provide some of the dominant epigenetic mechanisms that control gene expression. Histone modifications determine whether DNA segments assume a compact or relaxed structure. Activating histone marks are associated with relaxed DNA that is accessible to transcription factors, allowing expression of genes within the corresponding DNA segments. Repressive histone marks induce DNA compaction, rendering it inaccessible to the transcriptional machinery and resulting in the silencing of genes located in the corresponding DNA segments. As the genes in question may control cell division, growth and survival, epigenetic regulation of their expression may constitute key determinant of cancer emergence, maintenance and resistance to treatment.

Increasing evidence suggests that epigenetic changes play a critical role in the development of paediatric cancers. Many solid paediatric malignancies, particularly of bone and soft tissues, known as sarcomas, arise as a result of unique reciprocal chromosomal translocations that give rise to fusion genes, which encode fusion proteins found only the in the cancer cells. These fusion proteins provide a diagnostic signature for these particular types of cancer, and, more importantly, are uniquely responsible for their pathogenesis.

In the majority of cases, the fusion proteins behave as aberrant transcription factors or transcriptional regulators. They alter the gene expression repertoire of the cells, augmenting the expression of genes that promote cell survival and growth and, in some cases, silencing those that induce differentiation and quiescence. To execute their functions, these aberrant transcription factors may form complexes with chromatin-modifying enzymes and instruct them to reconfigure DNA structure, opening domains that in normal cells remain compact and, therefore, inaccessible to transcription, while condensing domains that are open in normal differentiated cells.

Chromatin modification may thus be harnessed to implement critical changes in the gene expression profile of the cells, rendering them more susceptible to uncontrolled division, inhibiting their differentiation and

maintaining them in an undifferentiated, pluripotent, state, which recapitulates features of normal stem cells. Cancer-associated fusion protein-driven chromatin modification may, therefore, mimic a developmental state and establish a cellular hierarchy within the tumour, which recapitulates that of normal developing tissues, albeit in an aberrant fashion.

Whereas the presence of the aberrant fusion proteins can provide the means to dissect the mechanisms underlying the development of the corresponding tumours, understanding paediatric cancer development also requires identification of the cells from which these tumours originate. Most normal cells are resistant to transformation. When a mutation that activates an oncogene occurs in a differentiated cell, the cell undergoes what is referred to as oncogenic stress, which causes the cells to stop proliferating and guides them toward a state of permanent growth arrest known as senescence. Senescence thus constitutes a powerful tumour suppressive mechanism and a safeguard against transformation.

However, some cells, particularly stem cells, are constantly engaged in the cell cycle, which requires suppression of some of the key growth inhibitory genes. These cells thereby already display some of the properties that transformed cells adopt. Various types of stem cells, from embryonic stem cells to more lineage-committed variants, are more susceptible to transformation than differentiated cells and may constitute the origin of a variety of cancer types.

Although transformation can occur in a differentiated cell, it requires reconfiguration of the cells state, referred to as reprogramming, that many potential oncogenic events may not be able to induce. A specific oncogenic event may first need to alter the chromatin structure, reprogramming the cell to acquire stem cell features, including the suppression of growth inhibitory genes, to provide permissiveness for transformation. In contrast, an oncogenic event that occurs in a stem cell may not need to induce reprogramming as permissiveness for transformation may be associated to the pluripotency with which the cell is endowed.

> "Although genetic mutations have long been thought to play the key role in the pathogenesis of cancer, it is becoming increasingly clear that in many malignancies, posttranslational and epigenetic modifications may play an equally important role, sometimes even dominating that of the genetic mutations."

We are pursuing the elucidation of the mechanisms that underlie paediatric cancer emergence, maintenance and progression. Our goal so to identify those mechanisms that may be targetable from a therapeutic standpoint. We are focusing on paediatric sarcomas whose pathogenesis is driven by unique fusion proteins described above. We have identified populations of committed stem cells, known as mesenchymal stem cells, which give rise to fatty tissue, bone, cartilage and other connective tissues, as the most likely cells of origin of several sarcomas. We have begun to shed light onto the mechanisms by which the fusion proteins associated with defined paediatric sarcomas transform these particular cells and to unravel the events that drive the development and progression of the corresponding tumours. Because they are unstructured proteins, the aberrant transcription factors that underlie sarcoma pathogenesis cannot be readily neutralised by specific drugs.

It is, therefore, essential to identify the downstream events that they initiate or key molecules with which they interact and that support their function, which could be amenable to targeting by newly designed or even repurposed drugs. We have identified some of the key posttranslational and epigenetic mechanisms induced by the fusion proteins that underlie sarcoma development and are now exploring approaches to target these mechanisms and develop new and effective ways to treat the corresponding tumours, which currently bear poor prognosis, despite aggressive multimodal therapy.

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Improving acute myeloid leukaemia (AML) outcomes

Bethany Torr, Campaigns and Advocacy Officer at Leukaemia Care explores how outcomes for acute myeloid leukaemia (AML) can be improved

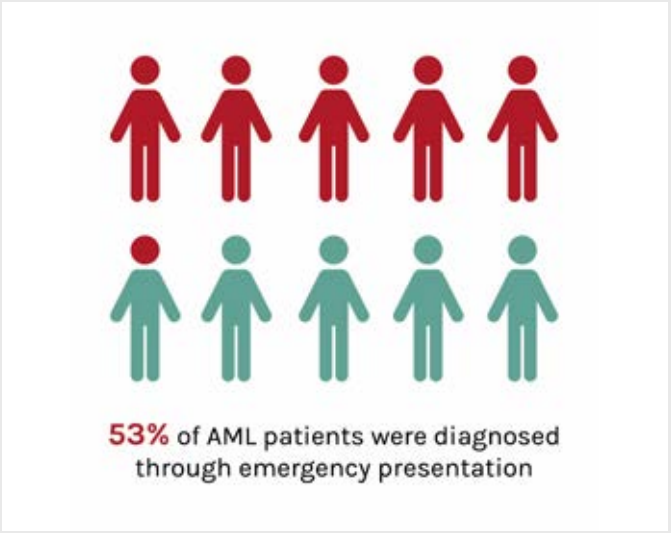
Each year around 3000 people in the UK are diagnosed with acute myeloid leukaemia (AML), affecting children, young adults and incidence significantly increasing from the age of 50 years old. Unfortunately, late diagnosis rates and a lack of treatment options for those unable to tolerate intensive chemotherapies are contributing to poor survival.

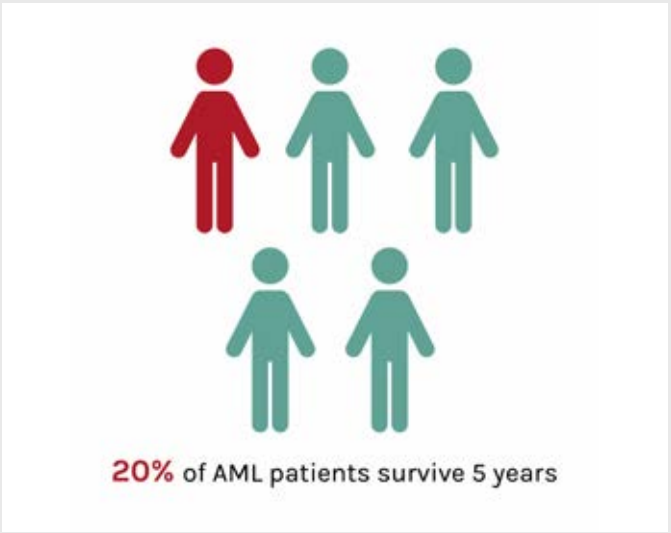
It is well-known that early diagnosis of cancer can improve outcomes and for AML there is no exception. As an acute, or quickly progressing cancer, the immature leukaemia cells take up space within the blood and bone marrow and the number of healthy, functioning cells rapidly decline. Patients can go from feeling relatively well to being dangerously ill in a short period of time and it is, therefore, vital that people know the signs and symptoms to look out for.

Unfortunately, the signs and symptoms of acute myeloid leukaemia are vague and often attributable to common illnesses. In a 2016 Leukaemia Care survey, the top symptoms reported by patients prior to diagnosis were: fatigue, feeling weak or breathless, easily bruising or bleeding, fever or night sweats and pain in the joints or bones.

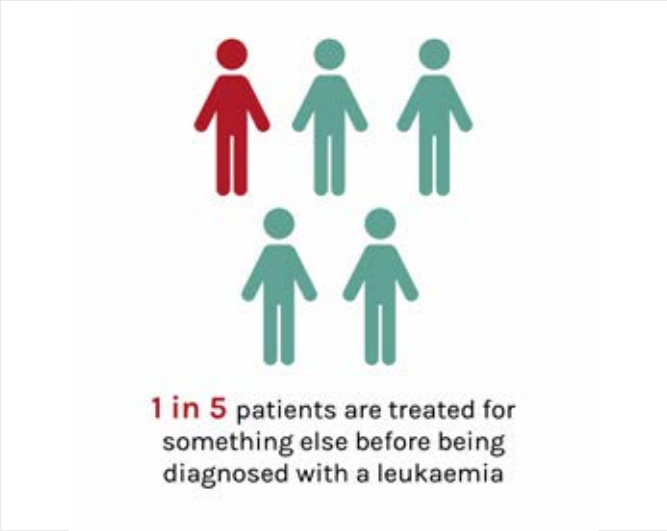
Despite nine in ten patients experiencing symptoms, 84% were not expecting to be diagnosed with cancer. Demonstrating that people are not aware that these symptoms are attributable to a blood cancer and are more likely to delay in visiting their GP. This could be significantly contributing to the extremely high levels of emergency presentation of AML (53% of all patients between 2006 and 2015) compared to the average for cancer (22%).

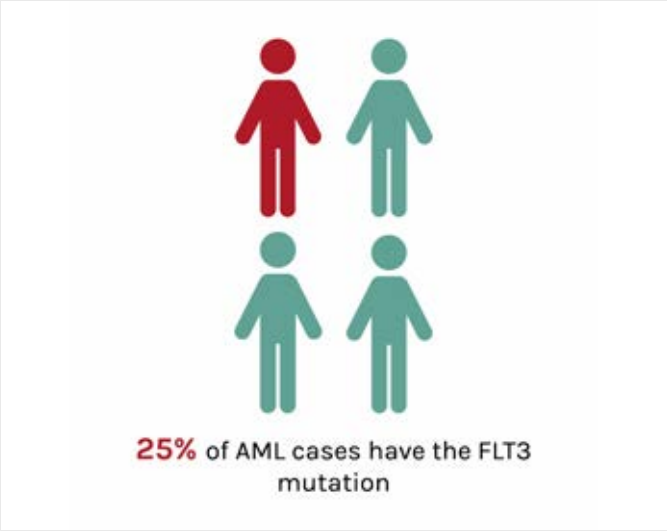
Not only does low levels of symptom awareness in the public cause delays in presentation, but there are also significant delays in diagnosis at the primary care level.





A GP may only see one case of leukaemia every four years and with the symptoms being like those of more common conditions, being able to identify potential cases of AML can be difficult. Leukaemia Care's survey revealed that more than 1 in 5 patients are treated for something else before being diagnosed with a leukaemia. This adds substantial delays in the patients receiving the urgent treatment required for AML, which could be easily avoided by a simple blood test.





Leukaemia Care is working to both improve public awareness of leukaemia and equip GPs to better recognise potential cases, in a bid to improve early diagnosis of leukaemia and save lives. Late diagnosis is, however, not the only factor contributing to the low survival rates for AML, estimated to be around 20% of patients surviving five years. Survival rates are directly associated with age and this is a consequence of older patients often not being fit enough to tolerate the intensive, non-specific chemotherapy treatments currently used for AML.

With the rise of genetics over the last few decades, there have been key improvements in the knowledge of what causes AML. Cancers are driven by genetic changes that cause the loss of normal control over cell division and cell function. There are several different genetic changes identified in the myeloid cells that are associated with AML and these can be indicators into the response to treatment and hence prognosis of a patient.

It is, therefore, better for the clinical treatment and management of AML to categorise it into subtypes, based upon the genetic mutations driving the leukaemia. As knowledge and understanding of the subtypes increases, more targeted therapies are being developed. This, in theory, means fewer side effects and a greater chance of successful treatment, by targeting the AML cells specifically. This will be of importance to the large proportion of older AML patients who are currently unable to have curative chemotherapy.

Recently, the National Institute for Health and Care Excellence (NICE) approved the first targeted therapy for AML, midostaurin, for use within the NHS. This drug is a small-molecule kinase inhibitor, that works specifically to block the FLT3 tyrosine kinase receptor. FLT3 mutations are the most common mutation driving AML, found in around 25% of cases. In clinical trials, when midostaurin was used in combination with chemotherapy, results demonstrate prolonged survival and better quality of life for patients.

Promisingly, building on the increasing knowledge of AML subtypes and developing further targeted therapies is likely to improve the outlook for more patients in the future. In the meantime, it is essential that work is done to raise awareness, improve early diagnosis and ensure patients are receiving appropriate cytogenetic testing to increase knowledge of AML subtypes. ■

Leukaemia Care
YOUR Blood Cancer Charity

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CD33-directed therapy: Current and future perspectives on targeted therapy in acute myeloid leukaemia (AML)

Mohammed Gbadamosi and Jatinder K Lamba from Department of Pharmacotherapy and Translational Research at the University of Florida explain CD33-directed therapy for acute myeloid leukaemia (AML), focussing on current and future perspectives

Acute myeloid leukaemia (AML) is a complex heterogeneous disease characterised by a variety of cytogenetic abnormalities and recurrent molecular mutations and aberrant expression patterns. As the most common and second most common leukaemia in adults and children respectively, many strides and efforts using new technologies and personalised treatment approaches are being undertaken to address and improve therapy surrounding the disease.

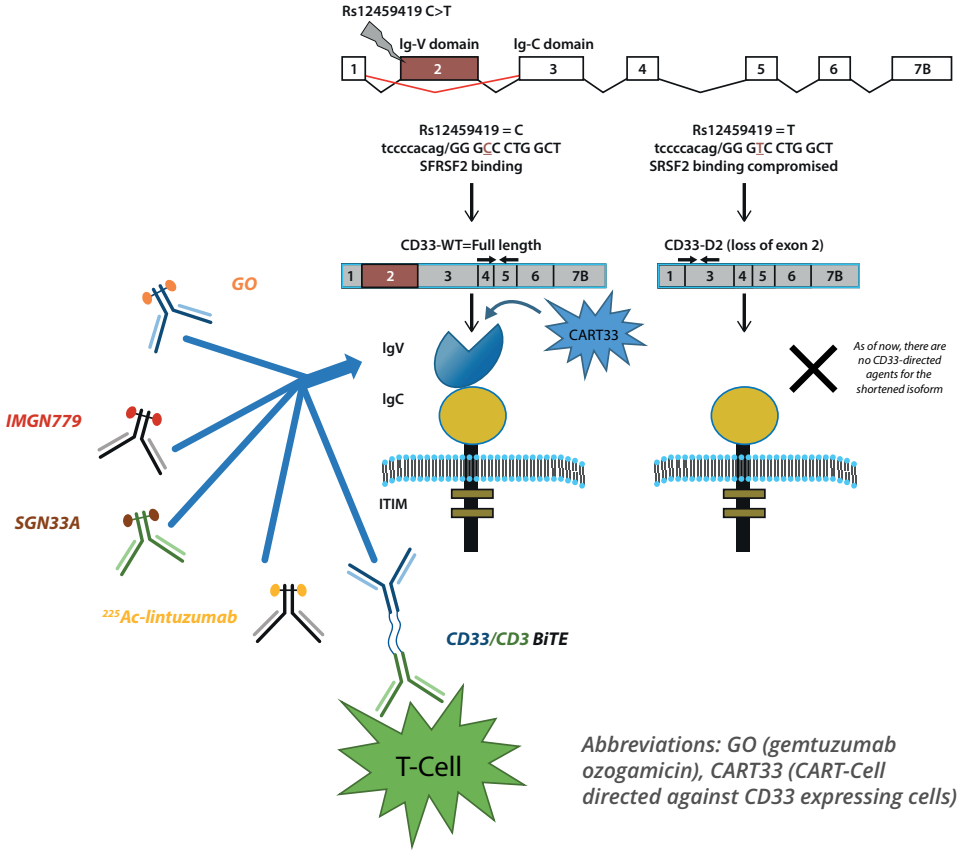
However, despite these efforts, outcomes surrounding the disease remain abysmal. In particular, for younger patients, complete remission (CR) rates of greater than 80% are achievable, however, the 5-year overall survival (OS) still remains relatively low at ~40% in comparison to other cancers due to high relapse rates. The outcome is even worse for older patients with five-year overall survival at less than 25%.[2] To address these poor outcomes, several targeted therapeutics have become popular additions to the mainstay 7+3 induction therapy.

Among these promising options are CD33-directed immunotherapeutics including antibody drug conjugates, as well as other CD33-directed therapies using newer technology like bispecific T cell engaging antibodies (BiTE) and chimeric antigen receptor T-cell (CART) therapy. The efficacy of these CD33-directed therapies is rooted in the ubiquitous nature of CD33 as an antigen marker present on AML blasts in 90% patients making it a potent distinguisher of AML blasts.[3] While its specific biological function is yet to be elucidated, CD33 is a known regulator of various cell processes related to calcium mobilisation, cytokine release and transcriptional activation.[4] Additionally, CD33 is internalised when engaged with antibodies thus making it an ideal vehicle for antibody-based therapies.

Emergent CD33-directed therapies

The recognition of this internalisation mechanism is the inspiration behind many of the ADCs targeting CD33 such as gemtuzumab ozogamicin (GO; Mylotarg™) which recently received reapproval by the FDA in September 2017. GO is structurally composed of hP67.6, a CD33-directed monoclonal antibody, covalently linked to the cytotoxic agent N-acetyl gamma calicheamicin.[5] The story of GO in AML has been remarkable, starting with accelerated approval in 2000 based on promising results from phase II studies, voluntarily withdrawn in 2010 due to increased induction death and no observed survival benefit in the post approval phase III study. Despite these setbacks, much has been and still remains to be learned from the story of GO and results from multiple subsequent phase III clinical trials have allowed recent breakthrough re-approval of GO as a low fractionated dose for treatment of AML.[6-8]

Following GO, several other ADCs directed to CD33 were designed and are currently undergoing development. Vadastuximab talirine (SGN33A) is generated through conjugation the CD33-directed antibody lintuzumab and a pyrolobenzodiazepine dimer.[9] Early clinical trials in relapsed AML have shown encouraging results, but unfortunately, due to a higher rate of deaths in phase III clinical trials, all SGN33A studies have been placed on hold. At this time, the cause of these early deaths is not clear, further work will be required before the potential of SGN33A can be re-evaluated for treatment of AML. IMGN779 is another ADC directed to CD33 using a humanised anti-CD33 antibody



Abbreviations: GO (gemtuzumab ozogamicin), CART33 (CART-Cell directed against CD33 expressing cells)

Z4681A and contains DGN462, a novel DNA-interacting IGN molecule. [10] With encouraging results from *in vitro* studies, phase I trials are for IMGN779 currently underway. Newer approaches using alpha particle therapy and other radioimmunology-based strategies have also shown encouraging results. ^{225}Ac-lintuzumab, the premiere the therapeutic of this drug class for AML uses ^{225}Ac to generate α-emitting isotopes, which induces a cytotoxic dose of alpha radiation killing AML blasts.[11] Promising preliminary results from a first-in-man safety and pharmacology study, as well as preliminary data on the feasibility of combinatorial treatment regimen are currently available.[12]

CD33 has also been explored for use in the realm of T-cell therapy. AMG330, a CD33/CD3 Bi-specific T-cell engager (BiTE), contains two fused single-chain monoclonal antibodies, which allows AMG330 to simultaneously take advantage of the pervasive nature of CD33 as an antigen in AML and the activation pathway of T-cells through CD3 binding.[13] In essence, AMG330 works by recognising CD33$^+$ AML blasts and forming a link to neighbouring T-cells. The connected T-cell then releases proteins, which induce apoptosis of the AML blast. *Ex vivo* and *in vivo* studies using patient samples and immunodeficient xenograph mice models respectively have demonstrated effective recruitment of T-cells by AMG330 and significant inhibition of tumour growth. Chimeric antigen receptor T-cell (CART) therapy, using CD33 as a target, is being investigated as well. CART cells targeted to CD33 (CART33) are developed by using a disarmed virus to engineer the T-cells to produce receptors for CD33 on their surface.[14] Preclinical experiments have demonstrated potent anti-leukemic activity of CART33, with much excitement surrounding the development of next-generation CART cells targeted to CD33 as well as other strategies surrounding the use of CD33 in CART therapy.

How can we improve CD33-directed therapy?

With a growing catalogue of CD33-directed therapeutics, interest surrounding treatment paradigms utilising CD33 have been piqued (Figure 1). Specifically, factors influencing crucial steps related to internalisation processes, release and activation of a therapeutic warhead, the intracellular levels and DNA binding capabilities of cytotoxic agents, as well as the efficiency of downstream DNA damage repair pathways and apoptotic pathways can play a critical role in defining the therapeutic efficacy of CD33-directed agents.

Expression levels of CD33 have been evaluated from multiple phase II and phase III clinical trials of GO. Previously, *in vitro* data have shown CD33 expression to be associated with greater GO efficacy; however, results from initial clinical trials in adult AML patients have shown conflicting results with CD33 expression with clinical response. Overall, the relationship between CD33 blast expression levels is inconclusive with follow-up studies needed, however, this information can be used to determine patients should receive CD33-directed agents based on the potential benefit to be gained.

In our group, we have described genetic polymorphisms in CD33 that may be related to the response of GO.[15] Through our studies, we have identified rs12459419 (C<T; Ala14Val) as a critical regulator of response. Located in exon 2, rs12459419 is a coding SNP present within four base pairs of the intron/exon junction and impacts the exonic splicing enhancer binding site for SRSF2 resulting in skipping of exon 2. The shorter CD33-isoform (D2-CD33) lacks the IgV-domain due to alternate splicing. Loss

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of the V-set antibody binding domain has two significant implications: it appears that most (perhaps all) available diagnostic antibodies are directed at the V-set domain, thus carriers of the T allele for rs12459419, would appear to be CD33 negative due to the lack of inclusion of the V-set domain. More importantly, loss of the V-set domain would directly affect the binding, internalisation and clinical efficacy of CD33-directed therapeutics. Altogether, these results suggest that loss of IgV domain due to presence of the splicing SNP compromises GO efficacy and, similar to expression levels, CD33 genotype can be used as a means of stratification to decide patients who will benefit from regimens including CD33-directed therapeutics.

While targeted immunotherapy is still relatively young in the realm of AML treatment, their potential in changing the field forever is palptiable. Ultimately, much more additional research is needed to understand the capacity of these therapeutics, the factors affecting efficacy and the potential limitations that may arise, however, the future for the role of immunotherapy in AML treatment remains bright and propitious.

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Prostate cancer: Enigmatic, with different shades

Professor Ghulam Nabi from the University of Dundee explores the subject of the enigmatic prostate cancer, with different shades

Prostate cancer accounts for nearly 27% of all newly diagnosed male cancers in the European Union, with 130 new cases detected every day in the UK. Despite significant improvements in the early detection of disease, almost six in 10 men with prostate cancer are diagnosed in their late stages.

Diagnosis of prostate cancer is usually made by physically examining the man's back passage (digital rectal examination) and a blood test aimed at an estimation of a protein which comes from the prostate gland, though not necessarily from cancer, called a prostate-specific antigen. The presence or absence of disease is confirmed using ultrasound-guided biopsies.

> "Prostate cancer is a spectrum ranging from very slow indolent cancers to the most aggressive types of the disease. The challenge in prostate cancer is not only early detection, but also assessing which cancerous lesions are aggressive so that treatment plans can be personalised."

At least 10 biopsies take place and it is necessary to take a sample from the gland in this way due to the inability of conventional ultrasound technique to pinpoint the location of cancerous lesions within the prostate. Our group at the University of Dundee believe we have found a new method offering more successful diagnosis and management of prostate cancer, however.

Shear Wave electrography-based ultrasonography techniques are a new way of detecting the disease. The technique creates shear waves within the gland and then measures their velocity as they spread around the tissues. The speed of these waves is affected by the stiffness of the tissues. Cancerous lesions are stiffer than healthy tissue due to the disorganised growth of cells and these are highlighted as red on the screen (see figure 1).

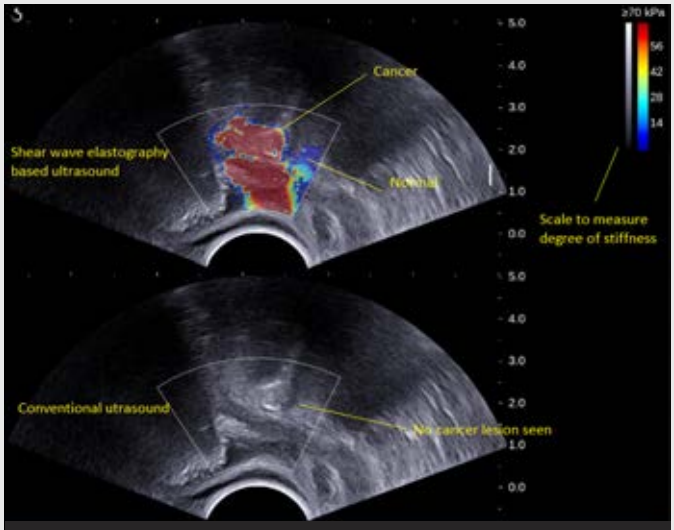

Figure 1

Prostate cancer is a spectrum ranging from very slow indolent cancers to the most aggressive types of the disease. The challenge in prostate cancer is not only early detection, but also assessing which cancerous lesions are aggressive so that treatment plans can be personalised.

There are various types of curative treatment options for disease localised to the prostate gland and these range from needle treatment of the lesions to complete removal of the prostate gland during surgery or treating using radiotherapy. The later can be achieved by focusing rays from outside (external beam) or placing radioactive material within gland in the form of seeds (brachytherapy).

The technique of SWE we have described provided early detection of cancerous foci within the gland, pinpointing

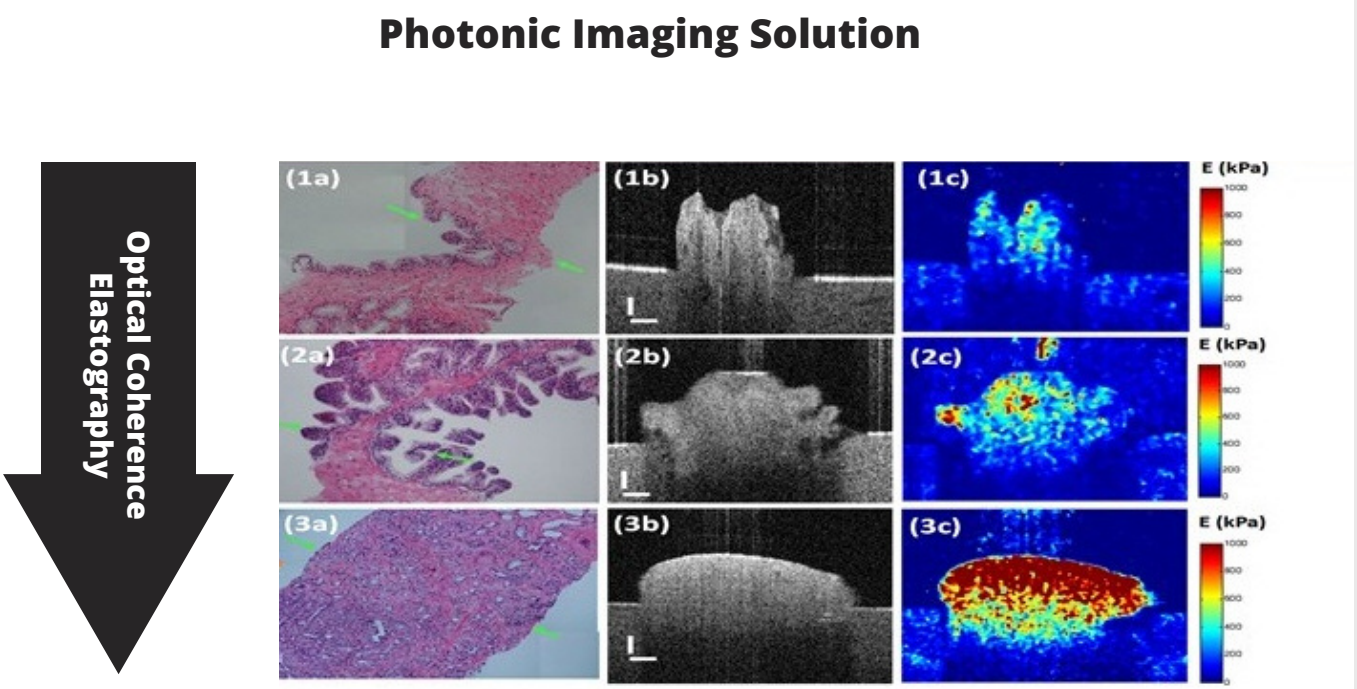

Figure 2: This shows comparison of histology (column 1) with plain optical coherence tomography (column 2) and optical coherence elastography (column 3) for different grades of prostate cancer

of these lesions and a degree of aggressiveness by quantitative measurement of the degree of stiffness, the redness that appears on screen. Using a simple, office-based test such as ultrasound should provide a degree of confidence in risk-stratifying men into different pathways and therapeutic options.

Assessing response or real-time monitoring of therapy is the equally important aspect of prostate cancer treatment. Our group in Dundee is the only dedicated consortium which has published work in optical coherence elastography (OCE). The latter is another way of assessing tissue stiffness using a specific wavelength of light. The way tissue handles the passage of light through it can provide invaluable information and can be used to through needles to assess real-time change in tissue stiffness (see figure 2).

Taken together, it is like someone has turned the lights on in a darkened room. We can now see with much greater accuracy what tissue is cancerous, where it is and what level of treatment it needs.

This is a significant step forward in detection and management of prostate cancer. We really need to see this looked at on a wider scale to build more data but there is clearly the potential to really change the way we manage prostate cancer. ■

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TGF-β signalling – Tumor biology in prostate cancer

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

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.

TGFβ signal transduction
Our research is focused on TGFβ signal transduction, tumour biology and molecular pathology, particularly in prostate cancer. TGFβ 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 TGFβ and poor prognosis with development of metastases. We have found that the ubiquitin-ligase TRAF6 is a crucial co-regulator of TGFβ-induced non-canonical and oncogenic responses, as it associates with the TGFβ type I receptor. TRAF6 promotes also expression and activation of proteolytic enzymes, such as TACE and presenilin1, which cleaves the TGFβ 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 TGFβ 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."

Combatting the increase in skin cancer throughout Europe

The mission of the European Skin Cancer Foundation (ESCF) is placed under focus by Open Access Government, in combatting the increase in skin cancer incidence across Europe, including malignant melanoma

The European Skin Cancer Foundation (ESCF) has a clear mission, to assist in developing and providing standardised prevention strategies and treatment guidelines on a European level. In this vein, they are, therefore, contributing to better primary and secondary prevention of these malignancies, as well as educating on the best treatment practices by means of training and exchanging knowledge.

Today, skin cancer is the most common malignancy in Caucasians. While the incidence of skin cancer has been increasing during the last few decades, its morbidity and the health burden associated with it have been underestimated by politicians, healthcare officials and the public, according to ESCF. Before you read on, a vital point worth pondering is that on a global scale, two to three million people develop skin cancer every year. That's quite a lot when you think about it.

The ESCF's website underlines that diverse treatment algorithms are followed in many countries across Europe, a point they go on to explain in their own words. "The diagnosis and management of skin cancer in Europe has been in the hands of dermatologists. According to the high incidence and limited availability of dermatologists, however, general practitioners will have to be involved in the care of skin cancer patients, especially of those with non-melanoma skin cancer."

Malignant melanoma

A malignant melanoma is the most dangerous malignant skin tumour – it develops through degeneration of the pigment-producing skin cells (melanocytes) and due to its often black or dark-brown colour it is usually termed as "black skin cancer".

Risk factors for malignant melanoma include a high incidence of sunburn in childhood and youth and when the condition is present in family history, such as those with light skin types. Other risk factors include artificial UV-radiation like tanning booths or therapeutic UV-radiation, for example in psoriasis or atopic dermatitis patients. People who work outdoors and take part in activities like aquatic sports, hiking, cycling or rock climbing are also at a higher risk.

ESCF's website reveals that nodular malignant melanoma is the most dangerous type of skin cancer because it grows early and can metastasize through ingrowths in blood vessels. ESCF explains that nodular malignant melanoma consists of dark, blue or black nodules or nods with an inclination to bleed. Appearing on just the hands and feet, the acral lentiginous melanoma can sometimes be found underneath the nails.

To a large extent, malignant melanoma develops on visible areas of the skin, indeed very rarely do they develop on internal organs or mucous membranes. ESCF's website goes on to develop this aspect of skin cancer in their own words.

"About 70% of malignant melanoma appears as superficial spreading malignant melanoma...In progress, dark nodules may appear or the mark may lose the pigmentation. These signs are not good, you should see your dermatologist immediately.

"You can find superficial spreading malignant melanoma mostly in areas of the skin which are not regularly exposed to the sunlight. In male patients,

they appear mostly on the back, in female patients on the lower legs. On the chronically sun-exposed facial skin of elder people, one can find the lentigo maligna melanoma, its incidence accounts for about 10% of malignant melanoma."

Education and research

When it comes to education, this could not be more important to the ESCF, who aim to promote skin cancer awareness and knowledge for several target groups, such as healthcare officials, politicians and the public. Awareness and education campaigns to enhance knowledge regarding skin cancer and the associated costs for the healthcare system are aspects of ESCF's work that they believe in very strongly.

In terms of educating those in the healthcare sector, ESCF stresses that general practitioners and dermatologists should be informed and trained on all aspects of skin cancer, including diagnosis, treatment, prevention – which will enable such professionals to carry out regular skin cancer screenings and to treat the early stages of skin cancer.

ESCF plays a part in developing prevention and treatment guidelines, in collaboration with all partners, with the view of providing standardised care for skin cancer patients all over Europe. In this vein, treatment guidelines will include special guidance for each form of skin cancer.

In closing, it's worth highlighting that ESCF strongly advocates the establishment of skin cancer centres around Europe that follow standardised guidelines and provide optimal care for patients. In addition, ESCF advocates research activities in the field of skin cancer, emphasising innovative modalities for skin cancer prevention, treatment and diagnosis in the future. ■

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Prevention, early detection and effective therapy in melanoma

Dr Bettina Ryll from the Melanoma Patient Network Europe gives a patient advocacy perspective.

The market approval of Ipilimumab in 2011 marked the begin of a new era for advanced Melanoma and the following five years and 10 further therapies revolutionised the treatment and the outlook of a cancer previously only known for its dire prognosis.

Melanoma is a cancer starting from the body's pigment-producing cells. Often labelled as 'skin cancer', this is the place where it most frequently starts. In rarer instances, however, melanoma also occurs in the eye, the inner linings of the body and the wrappings of the brain. Once melanoma spreads, a patient can only expect to survive six to nine months without one or several of the new therapies. Detected early, melanoma is usually considered curable by surgery. However, recent data demonstrates that even the smallest melanomas can recur over a long period of time and over 20 years will cost 15-30% patients their lives. With incidences rising worldwide, effective prevention, early detection and accessible treatments will therefore remain critical to reduce the mortality of this disease.

In the past, melanoma patient advocacy in Europe was fragmented and isolated. In the absence of effective therapies, the focus was on prevention, early detection and emotional support. The arrival of promising new therapies also triggered an evolution of European melanoma patient advocacy as patients suddenly had hope but struggled to evaluate and access new therapies.

The best cancer is the one you don't get – when effective prevention clashes with beauty ideals

Excessive exposure to UV-light and a history of sunburn in childhood are major risk factors for developing melanoma later in life. Sun-safe behaviour, in particular for children, is, therefore, one of the most effective preventive measures. Unfortunately, and despite increasing media coverage about the risks of melanoma, 'having a tan' remains associated with holidays abroad, leisure time and beauty. If anything, this demonstrates once more that knowledge and information alone are insufficient to induce behavioural change but need to be underpinned with legal frameworks and policies, for example, regarding sunbed use, the provision of shaded play areas for children and the ban of advertisements promoting sun-risky behaviour.

If you cannot prevent it, find it as early as possible – a call for effective early detection

Not every melanoma is preventable and past damage cannot be undone. Detecting a melanoma a single

millimetre smaller can considerably impact a patient's chances of survival. However, screening programmes come with their own challenges. The availability and quality of skin examination programs vary greatly between and even within countries, from whole-body inspection with mole-mapping and dermoscopy, to the ad-hoc visual inspection of lesions pointed out by the patient.

Education in self-examination, strategies how to reach groups at particular risk, the broad availability of high-quality skin screening programmes and the recognition that the proactive removal of suspect moles helps to reduce human suffering as well as cost in the long-term, will help to reduce the impact of what remains a deadly disease.

A therapeutic revolution in melanoma – albeit at considerable human cost

Prior to the arrival of the latest therapies, only 15% of patients with metastatic melanoma could expect to be alive after two years – compared to over 60% after three years on certain therapies today. While this development was met with incredulous awe and filled plenary sessions at major congresses, this revolution also had its casualties.

Unfortunately, scientific progress was not met by progress of regulatory and health-economic methodologies of the same speed as the new melanoma therapies belonging to new therapeutic classes did not behave like traditional oncology products. Surprising efficacy in a situation of high unmet need, combined with unexpected patterns and timing of responses and toxicity clearly demonstrated the limitations of traditional RCTs (randomised controlled trials), a methodology originally developed to detect small to medium differences in large unselected patient populations treated with rather unspecific therapies.

Large effect sizes over the 'standard of care' DTIC known for its limited effectiveness, meant that the only option for melanoma patients to access new therapies was in equipoise-violating trials, challenging the concept of free choice in the face of certain death.

Large effect sizes also meant that the resulting RCTs were small with very restrictive entry criteria.For example, patients with brain metastases were initially systematically excluded – and that despite the fact that metastasis to the brain is the main driver of mortality in melanoma. This first limited access to clinical trials for desperate patients, and then later restrictive reimbursement due to the limited external validity of the results.

As pharmacovigilance (safety of medicines) operates according to different statistical principles, small clinical trials also meant limited safety information and rarer side effects continue to present a considerable challenge in the management of melanoma.

The challenge of dealing with these novel therapies found its reflection in inappropriate trial designs, delays in approval and reimbursement – all potentiated by their high cost. Ultimately, this led to the loss of patients lives that could have been saved and seriously questions our ability to successfully drive and adapt innovation for the benefit of European citizens.

The hope of surviving an otherwise deadly disease – together with the learnings from the HIV community that had successfully challenged existing drug development paradigms in the past- and greatly facilitated by today's internet tools for education, communication and collaboration initiated a rapidly growing European network of melanoma patients and carers that were no longer willing to simply accept the status quo, and is now known as MPNE, the Melanoma Patient Network Europe.

Today, MPNE is a multi-dimensional network system based on language, national or topic-specific interests and centred around an English-speaking core. With a substantial focus on education, MPNE allows melanoma patients to follow and act upon the latest developments in the disease and routinely covers major scientific events, like ASCO and ESMO. Motivated by the personal experience of the limitations of current drug development, MPNE is involved in initiatives on patient-centric clinical trial designs, innovation in regulation and health technology assessment and sustainable healthcare innovation in the hope that patients with other equally desperate disease benefit from and do not have to repeat the learnings in melanoma.

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How using data can transform asthma care in the UK

Kay Boycott, Chief Executive of Asthma UK tells us how using data can transform asthma care today

The UK has one of the highest asthma death rates in Europe – with three people dying each day from an asthma attack – and the problem is getting worse. In the five years from 2011 to 2015, there was a 20% increase in lives lost to the condition. Only five of the 33 countries in Europe have worse asthma death rates.

The statistics are particularly concerning because, as the 2014 National Review of Asthma Deaths showed, two out of three of these lives lost to an asthma attack could be saved with basic care. There are 5.4 million people with asthma in the UK, all of whom should be reviewed at least annually by a health care professional, and yet the latest Asthma UK care survey showed 65% of people with asthma are failing to receive even basic care from their healthcare professional.

This is unacceptable, and it is too simplistic to use mounting pressure on the NHS as the explanation. There is also a long-standing, widely-acknowledged complacency about this common and chronic condition. This is even though people with asthma tell us that there is nothing as scary as being unable to breathe – the stark reality of an asthma attack. They also tell of the profound, but often hidden impacts on their health, work and relationships. Even for some people with asthma, it's too easy to think 'it's only asthma', with them not realising an asthma attack can be fatal. At Asthma UK, we work hard to raise awareness of the seriousness of asthma and encourage people to actively manage their asthma to stay well, through our website, online communities, nurse-staffed helpline, WhatsApp and e-mail services.

But more needs to be done to tackle this misunderstood, widespread and pernicious problem. Of course, more funding for asthma research to better understand asthma and to find a cure is important. However, to ensure this funding is maximised, we also need to ensure patient data is shared and used across the NHS, with researchers and health technology innovators. This will drive more joined-up care. Most of all it needs to prevent tragedies like the death of 13-year-old Tamara Mills – who was seen 47 times in different parts of the NHS in the four years leading up to her death. If there had been transparent, robustly managed and safeguarded data, this could have helped to identify that Tamara's care needed to change.

Data-driven technology already exists. For example, smart inhalers – which track, monitor and prompt medication use – could enable a patient's asthma to be monitored year-round, rather than at an annual review appointment. This would provide a more up-to-date and accurate picture and allow for personalised care, potentially reducing hospital admissions and even preventing asthma deaths. Used consistently across a patch, it could enable NHS Trusts and commissioners to stratify risk and allocate their resources effectively.

The cumulative data from new technologies could also be also be shared with researchers, to inform new treatments and services. While we know that asthma attacks are caused when the airways constrict in response to a trigger or environment, we don't know why it affects certain people rather than others and why it does so in different ways. Such is the variability of symptoms and triggers; leading experts now think that asthma is actually an umbrella term for a number of respiratory diseases.

A better mechanistic understanding of asthma means more effective ways to diagnose and treat the various types – and hopefully, discover a cure. The current "trial by treatment" approach is crude and can lead to sub-optimal care, with the risk of over-diagnosis and side effects which could be avoided. It is also an ineffective way of using NHS resources and with a new generation of promising, but potentially expensive, biological treatments entering the market there is an even more pressing need for more accurate diagnosis.

The topic of health data sharing is sensitive, and we need a continuous dialogue with citizens about where the boundaries and safeguards need to lie. In Asthma UK's new report, Data sharing and Technology: Exploring the attitudes of people with asthma, we gathered the views of over 3,000 people with asthma about the opportunities and risks of data sharing and digital health technology to transform asthma care.

Our report reveals that there is a real appetite amongst people with asthma to share their data. Almost nine in ten people with asthma in England (83%) said they supported their data being shared to improve NHS services, and a further 88% said they would happy for it to be used for further research into the condition.

The asthma population is vast and diverse, and with so many willing to share their data, this provides healthcare professionals, policymakers and scientists with the confidence to test new services and products informed by data. It also enables a much better understanding of asthma. The lessons we learn from effectively using data and health technology could also pave the way for innovations and better care for people with a host of other medical conditions.

But technology and public attitudes will keep changing. That's why there needs to be a continuous and informed public dialogue about the risks and benefits of data sharing and what is considered appropriate in terms of safeguards. Healthcare professionals need to play an active role in explaining to patients how data sharing can save lives. None of this is familiar or easy, but the NHS has a huge opportunity to take a global leadership role in revolutionising care by leveraging data and new health technologies at a scale not seen in other countries. Most of all, we hope this provides new options for the UK to improve the currently shocking death rates from asthma. ■

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Asthma: Understanding chronic inflammatory lung diseases

Michael Roth, Research group leader at the University & University Hospital Basel explores the current state of chronic inflammatory lung diseases, from the molecular biology perspective

Chronic inflammatory lung diseases are the most frequent non-communicable diseases worldwide. The cause of the increasing frequencies of asthma, COPD and fibrosis is largely unknown and cannot be explained well with the available knowledge. The same applies to the origin of the pathologies. What causes asthma? Allergies are only found in 50-60% of patients. COPD is mainly caused by cigarette smoking, but fine dust, toxic gases and working in agriculture are independent causes. Lung fibrosis is most often a disease of the ageing lung, but its cause is unknown. Using primary human diseased lung cells, we aim to understand the pathogenesis of the diseases and use this knowledge to find better therapies.

Understanding chronic inflammatory lung diseases from the molecular biology perspective: Part I – Asthma

Chronic inflammatory lung diseases are the most frequent non-communicable diseases worldwide. Currently, there are over 450 million people suffer from either asthma, COPD (smoker's lung) or fibrotic lung disorders. It was estimated in 2015 that the number of asthma patients doubles every ten years and COPD was the fourth most frequent cause of death.

The cause of the increasing incidences of asthma, COPD and fibrosis is largely unknown and cannot be well explained with our current available knowledge. This also applies to the origin of the diseases. In this issue, our focus will be on asthma, while COPD and fibrosis will be described in the subsequent issues.

Given that allergies are only diagnosed in 35-60% of asthma patients, what really causes asthma? The discrepancy between different studies that investigated allergies as the cause of asthma may be explained by the geographic locations of the study cohorts, the range of allergens used for detection of atopy or the incomplete information of the patient history. Patients with allergic asthma are characterised by increased IgE blood levels and neutralising IgE by humanised antibodies is a novel effective therapy which reduces inflammation. However, studies on the long-term effects of neutralising IgE on lung function and structure are missing. Thus, it is unknown if neutralising IgE reduces airway wall remodelling in asthma and thereby improves lung function.

Asthma can also be caused by physical stress such as exercise in sports, or sudden changes in air humidity. It is well known that many Olympic athletes in winter and water sports develop asthma-like symptoms only during their training sessions. Chlorinated water from swimming pools was considered to cause asthma but this hypothesis could neither be proven by animal models nor investigations on humans. Inhaling humid air may change the osmolarity of the lung and thereby lead to constriction of the airways.

Regarding winter sports, the inhalation of cold air can also lead to asthma. Similar as sudden changes to hot air as reported in dry regions, such as the Saudi Arabian Peninsula, Australia etc. How changes in temperature result in asthma is not understood at all and recent studies in humans suggested that additional factors because asthma has to be present. There is no animal model which can simulate these conditions properly and cell culture models can also not be applied.

Another cause of asthma can be psychological stress. New studies implied that stress of the mothers during the last three months of pregnancy increases the risk of their children to develop allergic diseases and specifically asthma during the first five years of life. These observations are supported by the findings that, epigenetic factors have a huge impact on lung maturation during late embryogenesis and early childhood. The three major epigenetic events which have been linked to reducing lung maturation and the increased risk to develop asthma are: i) methylation of DNA and DNA regulating histones; ii) increased activity of mitochondria; and iii) deregulated expression of specific microRNAs. Despite the observation that these three epigenetic events can cause asthma, the initiating mecha-

nisms are not understood. Furthermore, there are differences comparing these three events in different cell types of asthma patients and thus, the conclusion is difficult to draw.

DNA and histone methylation can be triggered by cigarette smoke, hormones, pro-inflammatory cytokines and even changes of tissue water contents. Increased methylation can occur on specific DNA sections, which control the activity of inflammation or asthma relevant genes. The same applies for histone methylations, which can be restricted to specific gene activity controlling regions. DNA and histone methylation are usually reversible events, but this seems to be fixed in asthma. Moreover, studies over three generations have shown that methylation patterns can be inherited. The reason why methylation of certain DNA sections or histones become irreversible in asthma is unknown.

Methylation patterns could be responsible for the increased activity of mitochondria, which has been reported in asthma patients and is maintained in isolated airway cells of asthmatics. The over-active mitochondria increase the energy consumption, specifically for muscle cells and thereby can lead to hyper-reactivity of the airways. Moreover, active mitochondria may enable the muscle cells to proliferate faster when exposed to pro-inflammatory cytokines, which in turn increases the production of extracellular matrix. The result of the mitochondrial activity in asthmatic airway cells is hyper-responsiveness and increased the thickness of the airway walls, which limit the breathing capacity of the patients.

The number of reports on the effect of microRNAs on the pathogenesis of inflammatory diseases is increasing rapidly. In regard to asthma pathologies, modified expression of microRNA-16, -17, -18, -19, -21, -34, -145 have been reported most frequently. Interestingly, several microRNAs (miR-17, -19 and –21) have been linked to increased activity of mitochondria. A problem regarding the function of microRNAs in the pathogenesis of asthma is the fact that specific microRNAs are regulated in a cell type-specific pattern. For example, microRNA-19 is down-regulated in tissue forming airway cells of asthma patients, while it is up-regulated in the circulating lymphocytes of the same patients. The same applies to other microRNAs. However, some studies suggested that circulating microRNAs, especially microRNA-21 could be used as a marker for progressive asthma. Furthermore, methylation of DNA and histones regulate the expression of microRNAs

The above describes briefly how different molecular biological mechanisms contribute to asthma. It also highlights that these molecular mechanisms are linked to each other and should not be seen as a singularity. To understand how asthma is caused, we need to connect these mechanisms and study them as a whole system. The interaction of these mechanisms has to be seen like the "Ying-Yang" concept where the equilibrium point is considered to be the point we are searching for to achieve the optimal health of a person in the specific situation and condition towards personalised medicine.

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An introduction to shortness of breath (dyspnoea)

NHS 24 provides an introduction to sudden shortness of breath, which is also known as breathing difficulty (dyspnoea)

Sudden shortness of breath, or breathing difficulty (dyspnoea), is the most common reason for visiting a hospital accident and emergency department. It's also one of the most common reasons people call 999 for an ambulance.

It's normal to get out of breath when you've overexerted yourself, but when breathlessness (dyspnoea) comes on suddenly and unexpectedly, it's usually a warning sign of a medical condition.

The information below outlines the most common reasons for:

- Sudden shortness of breath and;
- Long-term shortness of breath.

This guide shouldn't be used to self-diagnose your condition but should give you an idea of what's causing your breathlessness.

When to call a doctor

You should call your GP immediately if you have sudden unexpected shortness of breath, as there may be a problem with your airways or heart.

Your GP will assess you over the phone and may either visit you at home or admit you to hospital. If your shortness of breath is mild or the result of anxiety, you may be asked to come to the surgery rather than a home visit.

If you've struggled with your breathing for a while, don't ignore it. See your GP as it's likely you have a long-term condition, such as obesity[1], asthma[2] or chronic obstructive pulmonary disease (COPD),[3] which needs to be managed properly.

Your doctor may ask you some questions, such as:

- Did the breathlessness come on suddenly or gradually?
- Did anything trigger it, such as exercise?
- How bad is it? Does it only happen when you've been active, or when you're not doing anything?
- Is there any pain when you breathe?
- Do you have a cough?
- Do certain positions make it worse – for example, are you unable to lie down?

"Heart failure can also cause breathing difficulties. This life-threatening condition means your heart is having trouble pumping enough blood around your body, usually because the heart muscle has become too weak or stiff to work properly. It leads to a build-up of fluid inside the lungs, which makes breathing more difficult."

Feeling like you can't get enough air can be terrifying, but doctors are well trained in managing this. You may be given extra oxygen to breathe if this is needed.

Causes of sudden shortness of breath

Sudden and unexpected breathlessness is most likely to be caused by one of the following health conditions. See the references at the end for more information about these conditions.

A problem with your lungs or airways

Sudden breathlessness could be an asthma attack.[4] This means your airways have narrowed and you'll produce more phlegm (sticky mucus), which causes you to

wheeze and cough. You'll feel breathless because it's difficult to move air in and out of your airways.

Your GP may advise you to use a spacer device with your asthma inhaler. This delivers more medicine to your lungs, helping to relieve your breathlessness.

Pneumonia (lung inflammation) may also cause shortness of breath and a cough. It's usually caused by an infection, so you'll need to take antibiotics.[5] If you have COPD, it's likely your breathlessness is a sign this condition has suddenly got worse.

A heart problem

It's possible to have a "silent" heart attack[6] without experiencing all the obvious symptoms, such as chest pain and overwhelming anxiety.

In this case, shortness of breath may be the only warning sign you're having a heart attack. If you or your GP think this is the case, they'll give you aspirin[7] and admit you to hospital straight away.

Heart failure[8] can also cause breathing difficulties. This life-threatening condition means your heart is having trouble pumping enough blood around your body, usually because the heart muscle has become too weak or stiff to work properly. It leads to a build-up of fluid inside the lungs, which makes breathing more difficult.

A combination of lifestyle changes and medicines or surgery will help the heart pump better and relieve your breathlessness.

Breathlessness could also relate to a problem with your heart rate or rhythm, such as atrial fibrillation (an irregular and fast heart rate) or supraventricular tachycardia (regular and fast heart rate).

Panic attack or anxiety

A panic attack[9] or anxiety can cause you to take rapid or deep breaths, known as hyperventilating. Concentrating on slow breathing or breathing through a paper bag can bring your breathing back to normal, but should only be

done when you are certain anxiety is the cause of breathlessness.

More unusual causes

These include:

- A severe allergic reaction (anaphylaxis);[10]
- Pneumothorax – partial collapse of your lung caused by a small tear in the lung surface, which allows air to become trapped in the space around your lungs;
- Pulmonary embolism – a blockage in one of the blood vessels in the lung;
- Idiopathic pulmonary fibrosis[11] – a rare and poorly understood lung condition that causes scarring of the lungs;
- Pleural effusion – a collection of fluid next to the lung and;
- Diabetic ketoacidosis – a complication of diabetes where acids build up in your blood and urine.

Causes of long-term breathlessness

Long-term breathlessness is usually caused by:

- Obesity or being unfit;
- Poorly controlled asthma;
- Chronic obstructive pulmonary disease (COPD) – permanent damage to the lungs usually caused by years of smoking;
- Anaemia[12] – a low level of oxygen in the blood caused by a lack of red blood cells or haemoglobin (the part of red blood cells that carries oxygen);
- Heart failure – when your heart is having trouble pumping enough blood around your body, usually because the heart muscle has become too weak or stiff to work properly and;
- A problem with your heart rate or rhythm, such as atrial fibrillation (an irregular and fast heart rate) or supraventricular tachycardia (regular and fast heart rate).

More unusual causes of long-term breathlessness are:

- Bronchiectasis[13] – a lung condition where the airways are abnormally widened, and you have a persistent phlegmy cough;
- Pulmonary embolism – a recurrent blockage in a blood vessel in the lung;
- Partial collapse of your lung caused by lung cancer;[14]
- Pleural effusion – a collection of fluid next to the lung;
- Narrowing of the main heart valve, restricting blood flow to the rest of the body and;
- Frequent panic attacks, which can cause you to hyperventilate (take rapid or deep breaths). ■

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10 https://www.nhsinform.scot/illnesses-and-conditions/immune-system/anaphylaxis
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Understanding the process of intravenous access

Virginia M Stewart, MD outlines when intravenous access may be needed and how the skilful process should be undertaken

Patients coming to the Emergency Department (ED) with shortness of breath may have characteristics that impede intravenous (IV) access. Such characteristics may include hypotension, dialysis dependence, morbid obesity, history of diabetes, sickle cell disease, or IV drug use. One prospective observational study identified nearly 1 in every 9 to 10 adults coming to an urban ED had difficult venous access requiring 3 or more IV attempts.[1] If peripheral IVs are not established, patients may need a central venous catheter placed for life-saving medications administered. In addition to requiring physician skill, central venous catheter insertion carries a risk of complications including infection, arterial puncture or an aneurysm, and pneumothorax. Ultrasound-guidance for peripheral IV placement (UGPIV) has prevented the need for central venous catheter placement in 85% of patients with difficult intravenous access.[2] UGPIV has been performed by Emergency Medical Technicians (EMTs) in prehospital settings, as well as nurses and physicians. Patients who have been identified as having difficult access have higher patient satisfaction scores when ultrasound is used in peripheral IV access attempts.[3]

Frequently, the large veins of the antecubital fossa are sufficient to place large bore peripheral IVs needed for resuscitation. The brachial and basilic veins are easy to locate. The brachial artery is generally flanked by 2 smaller veins and the median nerve. Anatomically, these structures are medial to the insertion of the medial biceps tendon. This tendon is palpable in the antecubital fossa as the patient flexes then extends the elbow. The basilic vein is located medial to the brachial vessels. Generally, it is more superficial, larger, and does not have an accompanying artery or nerve at the level of the antecubital fossa. As you move proximally up the arm (towards the head) the basilic vein dives deeper toward the humerus, and longer angiocatheters may be required for cannulation.

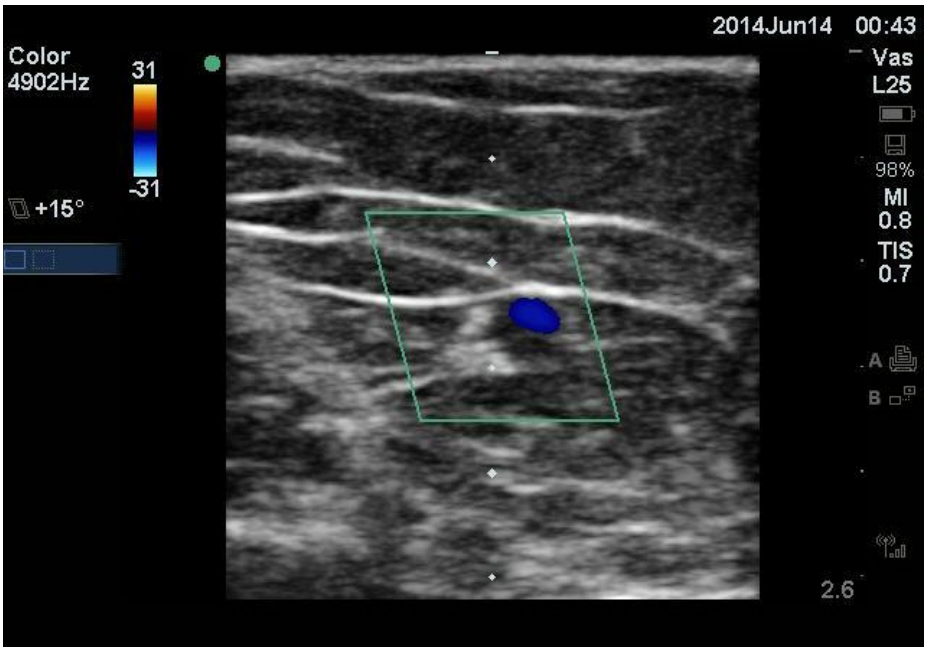

Figure 1: Short axis view of a peripheral vessel visualised with Colour Doppler (blue). The scale on the right of the screen demonstrates a total depth of 2.6 cm. A guide (white dots) in the centre of the screen marks each 0.5cm of depth. Therefore the depth of the vessel is between 1-1.5cm deep to the skin surface.

When considering vascular access, there is 2 views, a short and long axis view. Cannulation from the short axis is considered 'out of plane' since the needle is perpendicular to the probe. A short axis approach 'looks' at a cross section of the vessel. Long axis uses and 'in plane' approach with the needle entering from the probe marker end, and 'looks' along the length of the vessel. Figure 1 identifies a vessel using colour Doppler in the short axis view. Figure 2 demonstrates a long axis view with a hyperechoic angiocatheter. Figure 3 is the same vessel in long axis with the angiocatheter placed. While both approaches may be used for UGPIV placement, the

Figure 2: Long axis view of a peripheral vessel. The hyperechoic needle is visualized approaching from the top left of the screen into the vessel lumen.

benefit for the short axis is the ability to identify target veins as well as accompanying non-target (arteries and nerve) structures.

Identify the vein: remember the two C's

The two C's to remember for UGPIV access or for central venous cannulation are compression and colour (or Power) Doppler. Veins are thinner-walled and more easily compressed than arteries. This author advocates for finding a vessel first in the short plane, and compressing the vessel to ensure it is indeed a vein, rather than a less or non-compressible artery. Colour or Power Doppler may be utilised to determine if the pulsatile flow is consistent with an artery or vein. Colour Doppler uses red and blue to determine flow towards or away from the probe respectively. Power Doppler detects flow without concern for direction. Colour should not be relied on alone to determine arterial or venous flow due to the colour scale setting can be flipped or reversed, or aliasing can occur. Arterial flow is more pulsatile than venous. Venous flow may require distal augmentation (by squeezing the forearm distal to the probe) to appreciate the blush of colour.

Once the target vein is identified, the depth from the skin surface should be noted. A common mistake is to use an angiocatheter that is too long or too short. A general rule of thumb is to use a catheter length that is more than twice the depth of the vessel to ensure at least half the catheter lies within the vein. Sterile ultrasound gel should be used, with a covered probe to prevent infection. To prevent the risk of multiple punctures, this author advocates for first bouncing the needle on the skin over the point of entry. The tissue should deform at the top of the screen, and confirm the needle is over the target vessel. Once the skin is punctured, the needle tip is kept in view by angling the ultrasound probe until the target vessel is punctured.

To confirm placement, either a 'bubble study' with agitated saline may be performed or Colour (or Power) Doppler utilised to visualise saline flow through the cannulated vessel. A vessel that is not properly cannulated will demonstrate extravasation of saline around the vessel into the tissue before the tissue swells to a degree which is palpable on the surface of the skin. Figure 4 demonstrates confirmation of intraosseous (IO) lines utilise Power Doppler. A 10cc saline flush is rapidly pushed through the line, and flow is demonstrated beneath

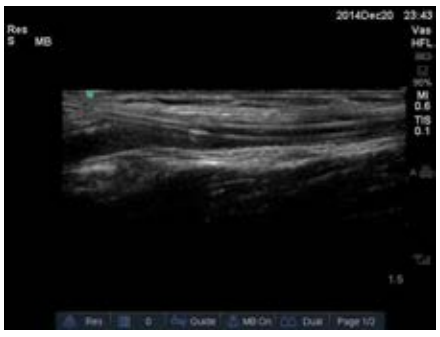

Figure 3: In this long axis view of a peripheral vessel the catheter has been threaded and is seen within the lumen of the vessel.

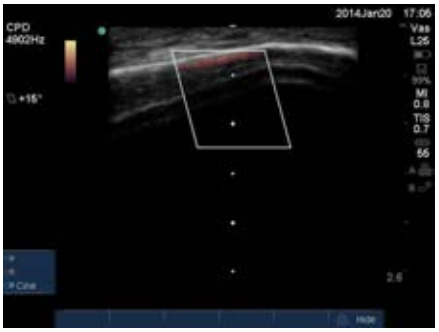

Figure 4: Power Doppler (orange) confirms placement of an intraosseus line within the distal tibia. The bright white line of the tibia cortex (in long axis view) is visualised at the top of the screen, with flow confirmation from a 10cc saline flush immediately distal (below) to the hyperechoic cortex.

the bony cortex in this adult tibia. If the line is improperly placed, the blush of colour using Doppler would appear in the soft tissues. For further information about UGPIV placement, visit: http://rmgultrasound.com/piv-access/

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Air matters... everywhere! Why our lungs need good quality air indoors

Isabel Proaño Gómez, Communications Manager at European Federation of Allergies and Airways Diseases Patients' Associations (EFA) explains why air matters, for everybody, everywhere

Air is everywhere, and we take it for granted. According to a recent study funded by the European Commission, poor indoor air quality (IAQ) is responsible for the loss of 2 million healthy years of life every year in the European Union [1]. And this data does not even include the impact second-hand smoke has on people's health in indoor environments. With Europeans spending 60-90% of their life inside, patients, children and the elderly are particularly vulnerable when breathing dirty air indoors.

The World Health Organisation has recognised since 2000 the right to breathe good IAQ [2], but this right is constantly breached. There is growing evidence that several indoor air pollutants are causing or exacerbating respiratory diseases, allergies, intoxication and certain types of cancer. For instance, 1 in 4 premature deaths from chronic obstructive pulmonary disease (COPD) are attributable to household air pollution [3].

The EU has taken very seriously the protection of our health from outdoor sources of air pollution passing legislation to reduce the emissions of the most harmful pollutants to health in the coming decades. However, we are still lacking legislation granting not only protection but also information to the public about indoor pollutants.

One of the reasons is that indoor air quality is mistakenly believed to be mostly affecting people in the developing world. But our buildings in Europe can make us sick too. More than 900 compounds harmful to

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health have been detected in indoor air [4]. Furthermore, IAQ requires a health and prevention approach across policies, but the EU is lacking a strong health focus within its institutions, to the point that health organisations have just launched the #EU4Health campaign [5].

Indoor air quality can be modified today by addressing other variables such as, the building emissions (construction, surface and finishing materials) and the indoor equipment (furnishing, heating and ventilation). Emissions and particles from cleaning products, from cooking and other occupant actions such as smoking and even the opening and closing of windows, can be shaped to reduce harmful impacts in the quality of the air.

As patient advocates, we are approaching the EU institutions to include IAQ in policies that have a threshold in the issue. It is the case of the recently revised Energy Performance of Buildings Directive (EPBD), which did not even mention the links and benefits of energy consumption reduction and health. At EFA, we took this legislative piece as an opportunity to bring the patients' perspective to the building renovation and construction sector. We called on the European Parliament to include a compulsory Indoor Air Quality Certificate in its EPBD revision, to prevent respiratory diseases, reduce premature deaths and guarantee the right to have clean air in indoor spaces for everyone.

Although several forward-thinking MEPS proposed to set up the certificate as an obligatory and reliable source of information and control of indoor air quality in the EU, to match energy certificate, the IAQ certificate was not adopted. As a first step, the final EPBD though includes IAQ considerations, such as establishing inspections for air conditioning and ventilation systems in European buildings and encouraging healthy indoor climate conditions in buildings under renovation [6].

Given that the EU is committed to the WHO action plan for the prevention and control of non-communicable diseases, by promoting clean air and reducing premature deaths by 25% by 2025, we are awaiting policy developments to improve the quality of the air we are breathing in closed spaces, as foreseen by the EU 7th Environmental Health Programme [7]. People with allergy, asthma and COPD are your radars!

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Acute respiratory distress syndrome – diagnostics and therapeutics

Cecilia Van Cauwenberghe, from TechVision Group, Frost & Sullivan provides a detailed analysis of acute respiratory distress syndrome, focussing on the evolving diagnostics and therapeutics in the precision era of medicine

Rezoagli et al., 2017, investigated acute respiratory distress syndrome (ARDS) epidemiology and etiology, concluding that ARDS can be triggered by a broad spectrum of local and systemic factors. Pneumonia, extrapulmonary sepsis and aspiration are the most critical risk factors for ARDS, along with additional demographic and environmental risk factors.

The acute lung injury prediction score (LIPS) is a model that introduces a series of risk factors and risk modifiers to predict patients' predisposition to develop ARDS by using routinely available clinical data even before they are admitted to the intensive care unit (ICU). Bauman et al., 2015, validated the use of LIPS for early recognition of ventilated patients at high risk for developing ARDS and mortality in ventilated surgical critical care patients. According to the researchers, early identification enables ventilator and fluid management optimisation strategies, thereby reducing the risk of developing ARDS and overall mortality.

Life-threatening interaction – pulmonary vascular dysfunction

Strongly characterised by diffuse alveolar and endothelial damage, ARDS is indeed the most severe form of acute respiratory failure. Wohlrab et al., 2018, emphasise in the impact of an increased pulmonary vascular permeability and a loss of aerated lung tissue that lead to bilateral opacity, pulmonary edema, hypoxemia, increased venous admixture and decreased lung compliance. As a result, patients with ARDS need supportive care in the ICU to maintain oxygenation and prevent even more adverse consequences.

Sipmann et al., 2018, focuses their investigations on the heart-lung interactions present in ARDS because of the critical pathophysiological alterations in lung parenchyma and pulmonary circulation accentuating the effects of positive pressure ventilation. This affection is designated as pulmonary vascular dysfunction (PVD) and it denotes the specific alteration of the vascular system in ARDS leading to an increase in pulmonary arterial (PA) pressure and pulmonary vascular resistance (PVR) and right ventricular (RV) distress and potential death due to heart failure. This interaction involves a series of factors that contribute to an inefficient ventricular ejection, which along with impaired pulmonary vascular mechanics, increases both arterial elastance and wave-reflection, additionally leading to RV afterload.

Therapeutic intervention broadly recurs to selective pulmonary vasodilators, lung protective mechanical ventilation strategies involving prone positioning and the open lung approach (OLA), to amend PVD by enhancing functional lung volume. Nevertheless, ARDS holds a high mortality rate mostly driven by pulmonary vascular interaction and RV afterload.

Advanced diagnostics and potential therapeutics

Next generation biomarkers

In the precision medicine era, discovery and validation of biomarkers constitute an essential need to help ARDS patients to prevent lung injury severity by directly conducting effective therapies. García-Laorden et al., 2017, have investigated the trajectory of many candidate biomarkers.

Unfortunately, specific biomarkers for ARDS are difficult to find due to the complex and heterogeneous pathophysiology of the disease. Therefore, scientists are more focused on recognising combinations of biomarkers and clinical predictors reflecting different aspects of diffuse alveolar damage (DAD) such as

epithelial damage, endothelial injury and/or inflammation, more prone to be identified.

Lin et al., 2018, have deeply analysed the metabolomics of patients with ARDS between healthy people, aiming to find metabolic markers with potential diagnostic values and prognosis. The authors found that caprylic acid, azetidine, iminodiacetic acid and ornithine had a positive correlation with the ratio of the arterial partial pressure of oxygen to fraction of inspired oxygen (PaO2/FiO2). The researchers also uncovered near a hundred of new metabolic pathways linked to these metabolites exhibiting significant statistical references to ARDS, which can be potentially used to judge the acuteness and envisage the prognosis of ARDS.

Receptor for advanced glycation end-products (RAGE) has been reported as a promising biomarker of lung epithelium injury as a pattern recognition receptor. Angiopoietin-2 (Ang-2) and surfactant protein D (SP-D) play a key role in endothelial junctional integrity. Due to their levels are significantly altered in patients with ARDS, they can be used for diagnostics. Similarly, interleukin-8 (IL-8) regulates neutrophils and monocytes chemotaxis in the lung, so that higher IL-8 concentrations have predictive value in high-risk patients for developing ARDS.

Therapeutic pipeline

Despite promising ongoing clinical trials being undergone, presently, there are no specific and effective pharmacotherapies to address the ARDS challenge. Principal attempts are based on a combination of therapies leveraging the advent of several adjacent technologies including small molecules agonists and inhibitors, interferons, nano-peptides, stem cells and microRNAs (miRNAs), among other innovations.

Aerosolised beta2-adrenergic agonists (β2-agonists) have been suggested to prevent the development of ARDS. SB-681323 is a selective p38 alpha inhibitor that may potentially inhibit the inflammatory response by interfering with the mitogen-activated protein kinase (MAPK) pathway, hence preventing inflammatory cascade events. As responsible for the well-functioning of the endothelial barrier function, interferon beta-1a may prevent vascular leakage. Nano-peptides, such as AP301, which activates the pulmonary epithelial and endothelial amiloride-sensitive sodium channel (ENaC) to facilitate alveolar liquid clearance, have been receiving increasing attention over the past decade.

Stem cell technology has also been proposed to regenerate lung tissue while modulating inflammation via secrete growth factors and cytokines. A further approach can be carried out by implementing miRNAs, small non-coding RNAs involved in the post-transcriptional regulation of various genes' expression, as both biomarkers therapeutics, due to miRNAs may control several signalling pathways associated with the onset of ARDS.

Acknowledgements

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Distinct ARDS morphotypes based on lung imaging patterns

Matthieu JABAUDON from Université Clermont Auvergne unveils his thoughts on distinct acute respiratory distress syndrome (ARDS) morphotypes based on lung imaging patterns

It has long been recognised that acute respiratory distress syndrome (ARDS) is a clinical syndrome with marked heterogeneity in its presentation and clinical course (see www.openaccessgovernment.org/acute-respiratory-distress-syndrome-2/34971).

One approach to dealing with heterogeneity has been to make a distinction between ARDS due to direct causes of lung injury, such as pneumonia or aspiration and ARDS due to indirect causes of lung injury, such as nonpulmonary sepsis or transfusion. It has been proposed that ARDS, caused by pulmonary and extrapulmonary diseases, may represent distinct syndromes with different respiratory mechanics and responses to ventilator settings (e.g., to the level of positive end-expiratory pressure, PEEP).

More recently, it was indicated in a biomarker study from Pr. Carolyn S. Calfee and al. (University of California, San Francisco) that the degree of lung epithelial and endothelial injury may be quite disparate with regard to underlying causes, with more severe epithelial injury (as assessed by plasma levels of soluble surfactant protein (SP)-D and soluble receptor for advanced glycation end-products (sRAGE) (see www.openaccessgovernment.org/new-biomarkers-of-lung-injury-in-ards/39157) in direct ARDS and more severe endothelial injury (as assessed by plasma angiopoietin (ANG)-2) in indirect ARDS.

Such findings may open new perspectives of testing treatments that specifically target the lung epithelium or endothelium. The current Berlin definition of ARDS, based on clinical and radiographic data, has probably hindered the identification of targeted therapies used to manipulate select biological mechanisms underlying ARDS.

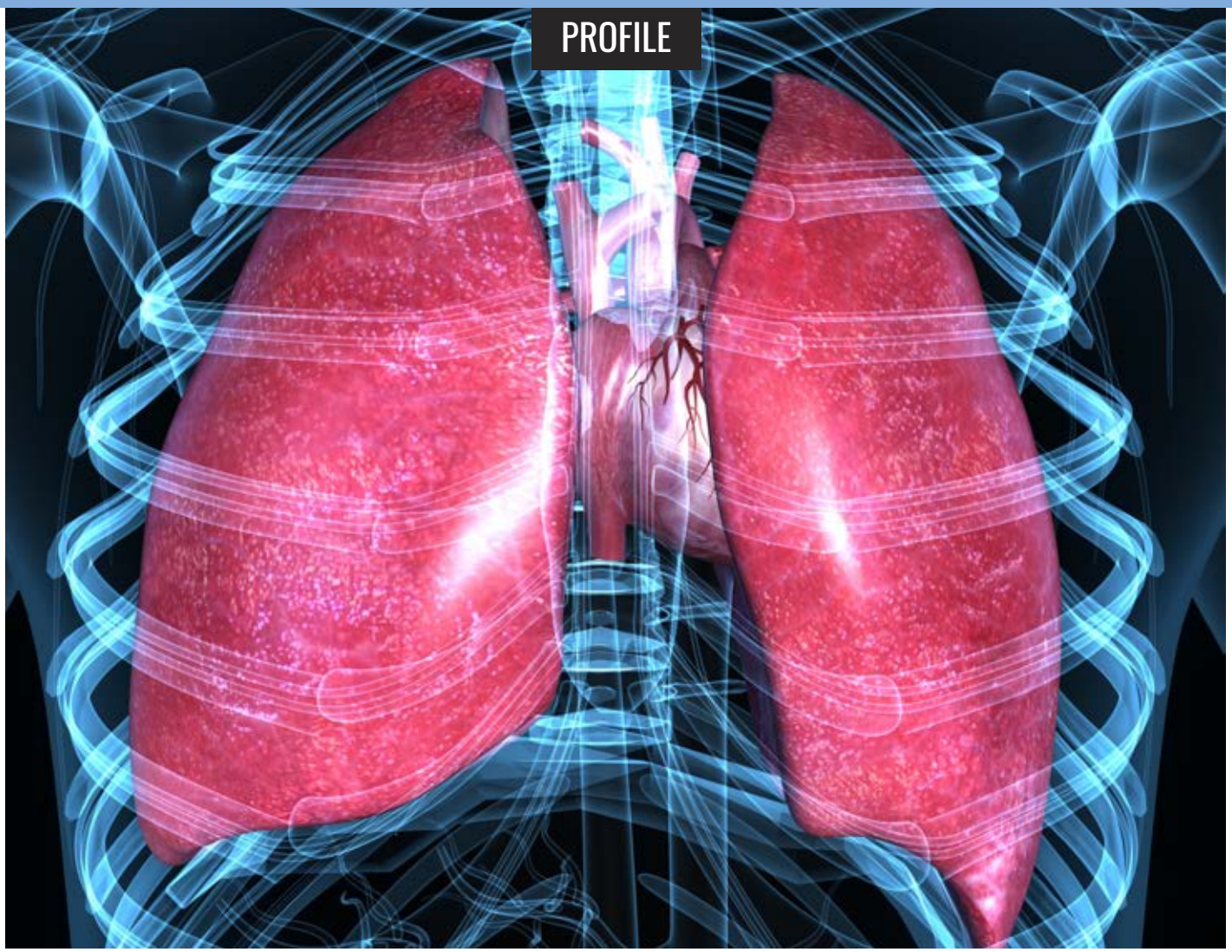
Although we have long been able to identify subtypes within ARDS (i.e., subsets of patients that do not necessarily imply differences in function, biology, or observable characteristics) that confer different prognoses, the novelty is that we are now able to identify phenotypes (subtypes of patients with distinct clinical, biological features and different natural histories) and endotypes (phenotypes (defined by a distinct functional or pathobiological mechanism) that may confer distinct response to therapy.

Patients with nonfocal (or diffuse) ARDS, as assessed by chest computed tomography (CT) (also referred to as nonfocal lung imaging phenotype or nonfocal morphotype) have lower lung compliance, a better response to PEEP and recruitment manoeuvres and higher levels of sRAGE than patients with focal ARDS.

In a recent prospective multicentre study on 119 patients with ARDS, Mrozek et al. measured PAI-1, SP-D, soluble intercellular adhesion molecule-1 and sRAGE within 24 hours of ARDS onset (CHEST 2016; 150(5):998-1007). They also performed a chest CT scan (or frontal radiograph and lung ultrasound when the patient was not considered transportable to CT) within 48 hours. Only plasma sRAGE and PAI-1 were significantly higher in patients with nonfocal versus focal ARDS in this study. Notably, 90-day mortality was significantly higher in patients with nonfocal ARDS than in those with focal ARDS (46% versus 21%).

"One approach to dealing with heterogeneity has been to make a distinction between ARDS due to direct causes of lung injury, such as pneumonia or aspiration and ARDS due to indirect causes of lung injury, such as nonpulmonary sepsis or transfusion."

Elevated plasma sRAGE levels and Simplified Acute Physiology Score II (SAPS II, a severity score used in critically ill patients) were independently associated with a risk of death, even after multivariate adjustments. These findings added to the growing literature demonstrating that plasma sRAGE correlated with lung injury severity and mortality in ARDS. In a murine model of hydrochloric acid-induced ARDS, sRAGE was significantly elevated in the pulmonary edema fluid and plasma in patients with ARDS in whom it was inversely associated with impaired alveolar fluid clearance (AFC), i.e. with the



physiological measurement of the rate of resolution of alveolar edema in ARDS.

Therefore, the working hypothesis has been that elevated plasma sRAGE could reflect the severity of alveolar epithelial injury in the lungs from patients with ARDS. This theory is supported by recent studies, including evidence in the ex vivo human lung. It has been demonstrated. Interestingly, a nonfocal ARDS morphotype is associated with an endotype of more severely impaired AFC, thus providing the first evidence of distinct functional patterns between focal and nonfocal ARDS. As RAGE pathway may play a major role in the mechanisms leading to AFC and its regulation (even though its precise roles are still under investigation), a growing body of evidence now supports an association between RAGE pathway, impaired AFC and ARDS morphotypes. This may fill a gap in the full recognition of a phenotype of lung morphology that could be linked to an endotype of impaired AFC and activated RAGE pathway.

Of note, such a hypothesis on endotypes could be of importance because both impaired AFC and higher plasma levels of sRAGE have been associated with the outcome because the biological plausibility is high, and it is inherent in the process of ARDS evolution. In this perspective, the results from the "Lung Imaging for Ventilator sEttings in ARDS" (LIVE) study (ClinicalTrials.gov identifier: NCT02149589; principal investigator: Pr. Jean-Michel Constantin, Clermont-Ferrand, France), that should be available soon, are expected because this multicentre randomised controlled trial was specifically designed to determine whether a personalised ventilation strategy tailored to ARDS morphotypes may improve survival, compared to a non-personalised strategy.

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Muscular dystrophy: Present concerns and foreseen opportunities

Cecilia Van Cauwenberghe from the TechVision Group at Frost & Sullivan provides a detailed analysis of the present concerns and foreseen opportunities around muscular dystrophy (MD)

Muscular dystrophies constitute a group of genetically dissimilar diseases related to the weakening and breakdown of skeletal muscle. At present, nine main categories and over thirty subtypes of muscular dystrophy have been recognised, based on alterations in the structure and/or function of the dystrophin protein caused by mutations in certain genes specifically impacting muscle function *(Saada et al., 2016)*.

Despite the prevalence and the estimated economic burden of over $795 billion associated with the whole set of types and subtypes of muscular dystrophy, the underlying biology and pathogenesis remains poorly understood (Gumucio, 2017). Nevertheless, recent advances in omics-based science, including the advent of artificial intelligence (AI) learning methods contributing to the analysis and the correlation of genome, proteome, epigenome, metabolome and lipidome data, are significantly accelerating disease pattern identification under a precision medicine framework. An in-depth knowledge of the mechanisms involved in both normal physiological functioning and disease status is becoming crucial for the development of efficient treatment strategies for muscular dystrophy.

Muscular dystrophies: A brief overview

Disease implications and collateral effects

Myopenia, a clinically relevant muscle wasting condition associated with the impairment of muscle function due to congenital or acquired causes including cachexia and sarcopenia, may represent a life-threatening disorder.

Cachexia is a multifactorial syndrome related to a variety of conditions leading to inflammatory muscle mass loss, hence potentially resulting from multiple different disease causes and genetic variability. Cancer patients are commonly affected by cachexia. Most immune checkpoint inhibitors utilised in cancer therapy involve the release of a cascade of immune systems that accelerates muscle loss. Moreover, nutritional support results are generally ineffective in these patients due to the fundamental molecular processes governing cancer-associated muscle metabolism and the epigenetic processes conducting muscle wasting phenotype *(Carr et al., 2017)*.

Sarcopenia is defined as low muscle function in the presence of low muscle mass. Sarcopenia is mostly associated with endocrine causes such as diabetes mellitus and insufficient insulin-like growth factor 1, as well as, decreased growth hormone and male hypogonadism, conveniently treated with insulin, testosterone and selective androgen and anti-myostatin activin II receptor molecules *(McKee et al., 2017)*.

Additional factors leading to sarcopenia are decreased physical activity, sudden weight loss, reduced blood flow to muscles, loss of motor neuron units and lack of vitamin D, generally treated with leucine-enriched essential amino acids and vitamin D, while increasing aerobic exercise.

A collateral effect associated with muscular dystrophy is myosteatosis, that is, the accumulation of pathological ectopic lipid with concomitant atrophy and fibrosis. Myosteatosis mostly follows chronic rotator cuff injuries. Scleraxis, a basic helix-loop-helix transcription factor required for the embryonic formation of tendon and the differentiation of tendon progenitor cells, is supposed to play an important role in adult tendon adaptation as well, along with the progression and consequences of myosteatosis on muscle metabolism and function. Although the pathways activated by excess lipid are poorly understood, the myosteatosis process starts with an initial acute inflammatory phase

due to a dysfunctional mitochondrial functioning unable to oxidise lipid. As a result, a lipid is accumulated over time, leading to a chronic, persistent inflammatory condition causing increased oxidative stress, tissue atrophy and muscle dysfunction.

Clinical approaches: The precision medicine era

Diagnosis and treatment opportunities in modern medicine

A recent focus in the field has centered on the ability to recognise the genetic mutations related to each subtype of muscular dystrophy, followed by the prospect of gene manipulation intending to reverse the disease progression. Indeed, genetic modulation via DNA and oligonucleotides and gene editing technologies including clustered regularly interspaced short palendronic repeats (CRISPR) are expected to hold the great promise of a cure for muscular dystrophy (Morley and Anker, 2017). The advent of precision medicine is significantly paving the way for the development of novel genomics-based early preventive strategies and potential treatments for a plethora of severely underserved conditions, such as those associated with some type of muscular dystrophy.

Breakthrough genetic therapies targeting muscular dystrophy

The estimated prevalence of Duchenne's and Becker's muscular dystrophy (DBMD) in the United States is 1 in every 7,250 males aged 5-24 years (Romitti et al., 2015). Both diseases involve the loss of function of the dystrophin gene, generally due to a disruption in the dystrophin protein reading frame. Therefore, an accurate correction of the dystrophin gene via gene editing, gene therapy or cell regeneration approaches would constitute a noteworthy therapeutic solution. In fact, recent approaches have been made intending to use recombinant adeno-associated viral (rAAVs) vectors and lentiviral vectors, as well as, sleeping beauty non-viral transposons to host truncated highly functional microdystrophin or microutrophin genes into the genome aiming to improve the dystrophin function.

Additional advances have been made with the development of DNA and RNA-based therapies, including smart oligonucleotides capable of interfering the splicing process to restore the dystrophin protein reading frame (Van Cauwenberghe, 2018). Indeed, the U.S. Food and Drug Administration (FDA) approved eteplirsen for the treatment of Duchene's muscular

Continued on page 131 →

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dystrophy (DMD). Gene editing approaches, more precisely CRISPR techniques, have been tested to genetically alter, enhance or inhibit specific genes related to muscular dystrophy in human stem cells (Iyer, 2017). Although most results achieved via gene editing approaches have led to unintended mutations, the synergy of this technology with human induced pluripotent stem cell (iPSC) therapies is still highly promising.

"Myopenia, a clinically relevant muscle wasting condition associated with the impairment of muscle function due to congenital or acquired causes including cachexia and sarcopenia, may represent a life-threatening disorder."

Final remarks

Gene and cell therapies, including gene editing and stem cells technologies, synergistically combined with data analytics and AI-based learning processes, constitute a powerful potential approach to efficiently treat muscular dystrophy. Associated with a deficient structure or function of the dystrophin gene protein, myopenia represents a therapeutic area that can be powerfully addressed under a precision medicine approach. Although further efforts remain to be made, the use of a patient's own genome, proteome, epigenome, metabolome and lipidome outputs as predictive and prognostic biomarkers for the adequate treatment and management of muscular dystrophy is making precision medicine a reality, propelling therapeutics discovery pathways through notable innovations in microRNA-based platforms, self-delivered RNA interference-based liposomes, anti-code therapeutics, therapeutic ribonucleases, antisense drugs, RNA splicing modulation, exon skipping treatments and microRNA programming, among many other disruptive approaches. ■

Acknowledgements

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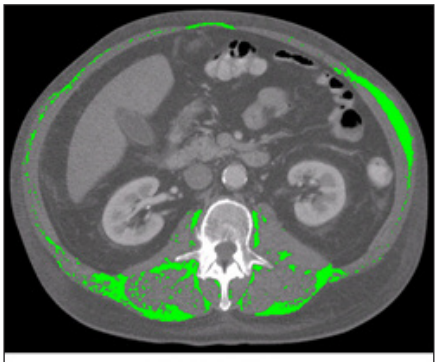
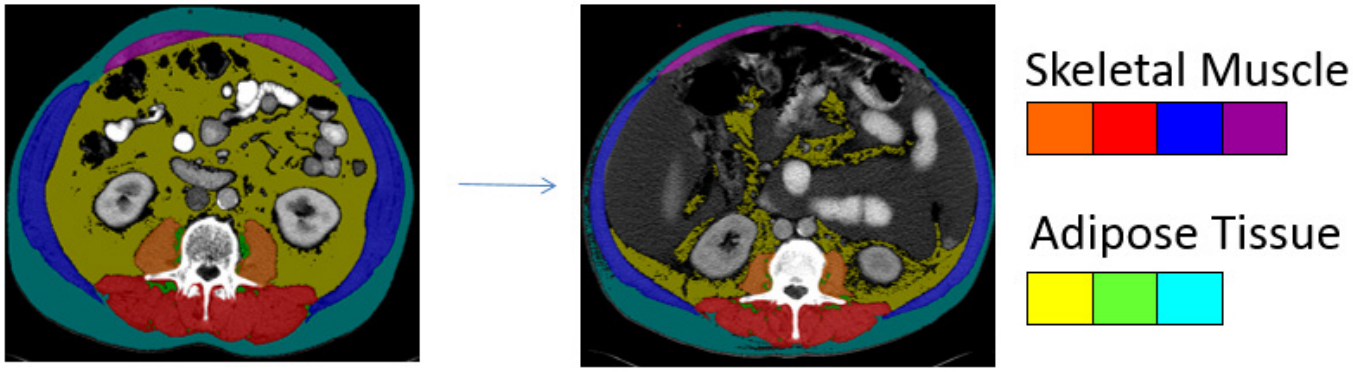
Disease-associated myosteatosis in people with cancer: Can it be treated?

Pathological fat infiltration into muscle is a feature of disease-induced muscle loss that significantly associates with shorter survival in people with cancer. Fat is associated with skeletal muscles in the form of intra-myocellular lipid droplets within the cytoplasm of myocytes as well as intermuscular adipocytes. These lipid stores are thought to provide fuels for skeletal muscle contraction, however, excess deposition of triglycerides within cells and organs that normally contain only small amounts of fat (such as liver, pancreas, skeletal and cardiac muscle) is defined as steatosis. Myosteatosis (steatosis of the muscle) is a pathological phenomenon reflecting an impairment of synthesis and elimination of triglyceride.

Myosteatosis is revealed in vivo by computed tomography (CT) imaging as muscle with low radiodensity combined with presence of intermuscular adipose tissue. The evidence for a relationship between low muscle radiodensity and shorter survival in people with cancer is building. Loss of skeletal muscle mass appears to generally occur with accumulation of adipose tissue into muscle. We reported that patients undergoing treatment for lung cancer lost muscle mass and concurrently gained intermuscular adipose tissue during treatment for cancer, whereas patients who supplemented their daily intake with fish oil containing eicosapentaenoic acid and docosahexaenoic acid [EPA+DHA (2.2 g/day)] maintained or gained muscle mass and experienced a decline in intermuscular adipose tissue over the same time period. This intervention also resulted in a greater response by the tumor to the drugs being used to

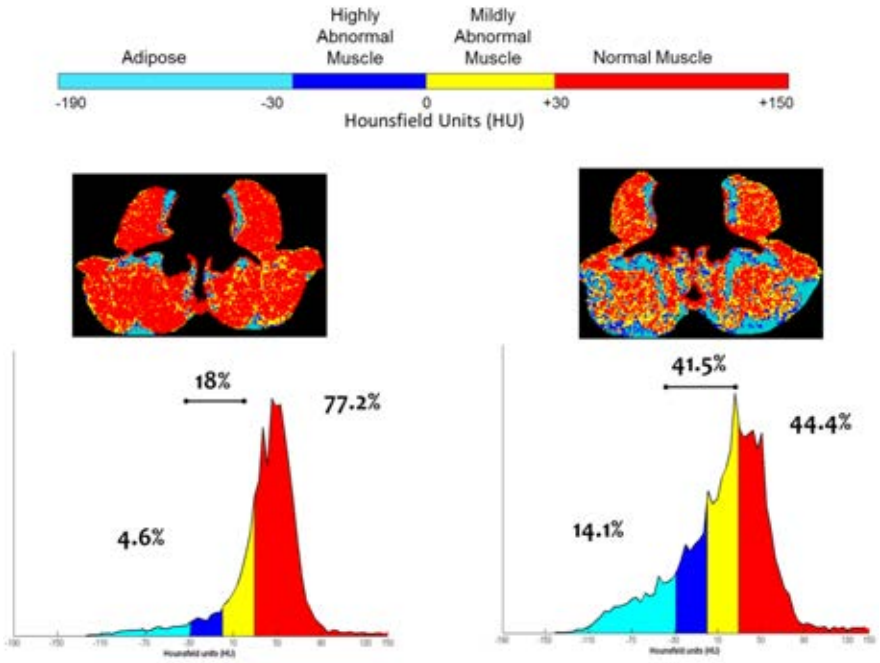


This slide shows a CT image from a cancer patient who underwent 16 weeks of first line platinum doublet chemotherapy for lung cancer. Only the intramuscular adipose tissue is shown in color



To quantify different tissues for body composition analysis using computed tomography imaging, a bony landmark is used to consistently measure the same region of the body across patients. The 3rd lumbar vertebrae is an established landmark in body composition analysis that correlates with amount of whole body muscle and fat. Each tissue attenuates radiation in a specific way which is recognised by a software program to enable skeletal muscles and different types of adipose tissues to be identified. Each tissue of interest is then color coded (see legend). When more than one CT image exists in the patient record, tissue changes over the trajectory of the disease can be determined. This image presents 2 scans taken approx 6 months apart at the same region within the same patient. The marked decline in muscle and adipose tissue is evident, concurrent with deposition of adipose tissue into muscle

Illustration of Variation in Muscle Radiodensity



An illustration of annotated CT images, and accompanying histograms of radiation attenuation showing the percentages of total tissue cross-sectional area within the ranges of adipose tissue in paraspinal/psoas muscles is useful to understand the problem of myosteatosis. This illustration shows the percentages of total tissue cross-sectional area within the typical attenuation ranges determined for the respective tissues for 2 subjects. Subject 1 is a 63 year old male with muscle characteristics at the median values for male cancer patients with a diagnosis of solid tumor at our centre. For Subject 2 there is extensive macroscopic adipose tissue and less than half of the cross sectional area of his muscles falls within the normal attenuation range. Overall, Patient I has a greater proportion of fat and low attenuation muscle, than muscle with normal characteristics. Patient II is remarkable in several respects, including extensive visible fatty infiltration and extremely high proportion of total muscle area falling within a range of attenuation values generally recognized to be abnormally low (adapted from Aubrey et al 2014)

treat the cancer. Therefore there may be multiple benefits of dietary fish oil to the cancer patient undergoing treatment.

To explore these observations that cancer patients supplementing with EPA+DHA experience an improvement in myosteatosis, we established a pre-clinical model to enable intervention with EPA+DHA at various time points in the cancer trajectory. We used an rat model bearing the Ward colorectal tumor and treated in a manner that mimics standard clinical care for this disease in humans with respect to the types of drugs used and the toxicities they evoke. Using this model we have demonstrated that the results align with our human data suggesting an improvement in muscle condition concurrent with a better response by the tumor to the anti-cancer drugs. Using this as the rationale for the next step of this line of questioning, we have planned a clinical trial upon which to text the biological efficacy of fish oil to reverse cancer- associated myosteatosis in a cancer population known to exhibit myosteatosis, verified by in vivo imaging of muscle features by CT scan. At the time of diagnosis and treatment planning, patients will be randomized and consented to consume EPA+DHA (2.2 g per day) until day of surgery (at least a 4 week period) or receive standard of care (no intervention). Muscle from the subjects will be collected at the time of surgery and prepared for analysis. Analysis of the muscle tissue will enable determination of differences in Triglyceride-fatty acid content (a hallmark of myosteatosis). We expect that this research will verify the tantalizing evidence we have in hand that suggests an improvement in pathological features of myosteatosis by dietary EPA and DHA. If so demonstrated, this work will provide critical translational knowledge required to effectively plan treatment interventions that have significant potential to impact the lives of people diagnosed with cancer, a major cause of death globally.

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The key issues around muscular dystrophy (MD) in Europe

Boris Šustaršič, President of the European Alliance of Neuromuscular Disorders Associations shares his thoughts on the key issues around muscular dystrophy (MD) in Europe today

According to official medicine, which relies on scientific findings, progressive neuromuscular disorders (NMD) are regarded as pathological physical changes. However, bearing in mind the new basic research findings in this field, I am more and more convinced that NMD should no longer be treated as pathological changes, but as a new physiological condition caused by genetic factors. Such a new approach would lead to fundamental changes in the medical and social treatment of persons with NMD. Nevertheless, our primary goal remains to ensure an appropriate quality of life together with support services and an inclusive society, which represent the basic conditions for dealing with persons with NMD in modern Europe.

The vital role that research plays in the MD field

For many decades, people with NMD listened with great hope to news about the results of basic research into human neurology, especially regarding certain neuromuscular disorders. The prospects sounded optimistic, but there was no information about new drugs that would tackle the progressive nature of these hereditary disorders.

The introduction of the drug for treating Pompe disease represented an important turning point. It was the patients' organisations that significantly contributed to shortening the period from laboratory discovery to clinical application of the new medicinal product. The introduction of the new drug Ataluren for persons with Duchenne muscular dystrophy followed a similar path: it was upon the appeal of patients' organisations that the medical authorities approved its provisional use. The new drug Spinraza for treating people with SMA (Spinal Muscular Atrophy) raises even more realistic hopes. It represents new forms of etiological treatment, while on the other hand, it signals that there will be no single treatment for all people with NMD but rather different drugs targeting individual genetic disorders.

However, a serious obstacle related to the existing and expected new drugs is their high price which leads to selective application. I hope that none of the new drugs will cause any serious secondary complications or adverse side effects. Another open question is what criteria to apply for evaluating the effects of new drugs? The physicians have much higher expectations than the people with NMD, who would be very happy even if the treatment only stopped the progression of the disease or helped strengthen individual body functions that significantly influence the quality of their lives.

The effect of MD on the muscles

Muscular dystrophy encompasses a group of more than 30 different clinical genetic disorders that are characterised by progressive skeletal muscle wasting and degeneration. It is a little-known fact to the public that neuromuscular disorders cause disability due to hereditary and other malfunctioning of certain genes. This means that there are several types of MD that progress at various speed and thus cause different types of disabilities. However, they all have certain features in common: the gradual and irrepressible degeneration of the muscle fibres from the motor neuron downwards, which means that the process is not present in the brain and the spinal cord but only affects the ability to walk or move the body due to weakening muscle power.

MD is not contagious and cannot be connected with the so called neurotic conditions and reduced intellectual capacity. It is, therefore, justifiable to enable young people with NMD to have access to quality schooling,

Boris Šustaršič
President

including higher education, so that they can grow into responsible people who can build a positive attitude towards themselves and their wider social environment.

Muscular and neuromuscular disorders cause the characteristic progressive disability. In children, the first signs of the disease usually start to appear between the ages of three to seven. As a rule, the muscles employed in gross power movements weaken first. Consequently, most children with NMD are forced to use a wheelchair before they reach the end of puberty and they are increasingly dependent on the physical assistance of another person who becomes a more or less inseparable companion in their 24-hour biological rhythm. Thus, their social life style changes completely. They are also entitled to numerous technical aids and appliances. No less important are living and working premises. With their cognitive function preserved or even emphasised in certain diagnoses, people with NMD can realise all social activities and achieve their life goals.

What is the extent of the disease today in Europe?

The disease affects up to 1 per mille of the population in some regions, but it is not equally distributed. Its extent depends on several factors, for example, which diagnoses are included in the group of neuromuscular disorders in certain countries and the historical background of certain nations and their biological diversity (biodiversity). Most NMD is of a hereditary nature. Nevertheless, in modern medicine, there are different opinions regarding the factors that affect the spontaneous incidence of the disease.

Why is it important to get the right care and support for the disease?

For those with NMD, it is vital to receive the appropriate medical treatment, encompassing various stages from early diagnosis which defines the type of disorder and the timeline of disability progression, to regular restorative medical rehabilitation which prevents secondary complications and preserves general health condition despite the chronic disease.

With scientific progress, new medical substances are developed, which basically slow down or in some cases even stop the progression of the disease. Quick access to treatment is, therefore, equally important as early diagnosis. Clinical studies and the results of treatments have shown that some forms of muscular dystrophy can be successfully treated. The genetic treatment of muscular and neuromuscular disorders shows a promising future and heralds radical changes in the medical treatment of muscular dystrophy.

In addition to insufficient access to modern forms of treatment, problems pertaining to the disease are mainly caused by the still prevailing nihilistic attitudes in certain European countries towards persons with NMD. Those with NMD are often poorly educated, do not have appropriate technical aids, have a reduced quality of life due to late or no corrective surgery taking place, live in an inappropriate housing environment or lack sufficient physical assistance from other people.

Fortunately, the situation regarding the holistic treatment of those with NMD and their social participation is changing for the better in most European countries. As an umbrella organisation, EAMDA empowers the role of muscular dystrophy associations, helping them to be better informed and stronger. In cooperation with partner organisations such as EDF (European Disability Forum), EPF (European Patients' Forum), EFNA (European Federation of Neurological Associations), EURORDIS and others, EAMDA participates in the decision-making processes at the national, international and European levels – aiming to realise the expectations of people with NMD for an inclusive and accessible society. ■

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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

Duchenne 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 important 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.

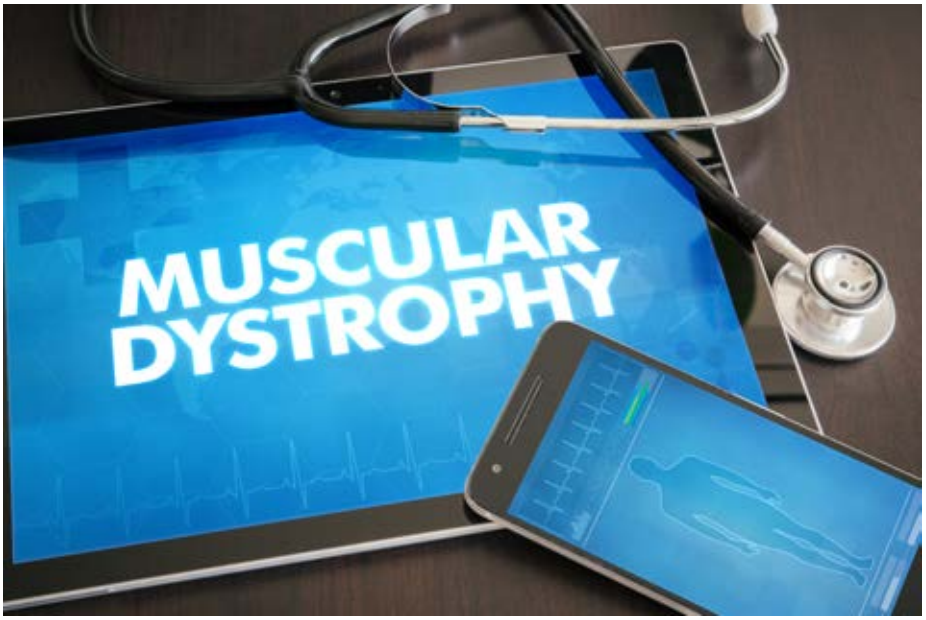
The gene correction strategy can be further subdivided as shown below.

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 iPSCc. 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 then 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.

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Work-related musculoskeletal disorders: The path towards absolute prevention

Cecilia Van Cauwenberghe from Frost & Sullivan's TechVision Group provides a comprehensive overview work-related musculoskeletal disorders, focussing on the path towards absolute prevention

Covering any injury, damage or disorder of the joints or other tissues in either the upper limbs or the lower limbs, as well as, the back, work-related musculoskeletal disorders (WRMSDs) can be categorised as work-related upper limb disorders (WRULDs), work-related lower limb disorders (WRLLDs) and work-related low back disorders (WRLBDs), respectively. In all cases, a heterogeneous group of conditions is observed.

WRULDs may affect any region of the neck, shoulders, arms, forearms, wrists and hand, leading to potential affections such as tendonitis, carpal tunnel syndrome, osteoarthritis, vibration white finger and thoracic outlet syndrome, among many other complications lacking so well-defined signs and symptoms, implicating tenderness, aches and pain, stiffness, weakness, tingling, numbness, cramp and swelling. Major causes associated with WRULDs are repetitive work, uncomfortable working postures, sustained or excessive force, long-time carrying out the same task, the poor working environment including inappropriate temperature, lighting and humidity, as well as, work overload involving work pressure, job demands, lack of work breaks.

WRLLDs affect the hips, knees and legs. Among the most commonly recognised, hip and knee osteoarthritis, knee bursitis, meniscal lesions and tears, stress fracture and reaction injury and varicose veins are remarkable. Major causes are related to repetitive kneeling and squatting, fixed postures without a break and frequent jumping.

WRLBDs constitute a major health concern in the developed world, involving both low back pain and low back injuries. According to the paper published by Leclerc, 2016, some negative effects of WRMSDs related to specific occupational exposures are mainly short-term issues. However, for WRLBDs, long-term effects are dramatically important and may lead to complete work disability.

Operational risk factors

Prolonged exposure to ergonomic risk factors may lead to MSDs. Among the work actions potentially causing MSDs, those most commonly observed are exerting excessive force, repetition of movements, awkward postures or unsupported positions that can compress nerves and irritate tendons, static postures held for long periods of time that can restrict blood flow and provoke muscle atrophy, quick bending and twisting motions, compression from grasping sharp edges, vibration, cold temperatures, insufficient recovery time.

> "The use of emerging sensing technologies at workplace represents a more universal approach to health status monitoring focused on integrating cutting-edge technologies to deal with healthcare data acquisition and their utilisation for WRMSDs prevention."

Furthermore, the accumulation of years of exposure to occupational demands must be taken into consideration. Klussmann et al., 2017 analysed manual handling operations (MHO) as one of the principal risk factors for WRMSDs, following different methods to estimate the risk validated in regard to criterion validity, reliability and utility.

Absolute prevention – leading-edge ergonomic science and innovation

Obligations and recommendations

The prevention of WRMSDs risks is not only a socio-economic and health advice but also an employer's responsibility, commitment and obligation within the occupational risk assessment. Overall, the risk evalua-

tion should include detection of the work tasks involving greater probability of derive in a WRMSD, ergonomic analysis of these work tasks and situations, critically analysing workstations, activity, work environment and operators' complaints, evaluation of biomechanical, organisational and psychological WRMSDs risks.

The European Agency for Safety and Health at Work (EU-OSHA) proposes a series of preventive actions consisting of drawing up ergonomic solutions to decrease or ideally eliminate those evaluated risk factors. The checklist comprises the ergonomic design and proper use of work tools, appropriate product design, ergonomic layout of the workstations and the physical work environment, optimised manufacturing configuration, ergonomic pattern of the activity implying alternation of repetitive and non-repetitive tasks, different muscle groups demands, short and frequent breaks, short time rotation in different workplaces, settle adjusting periods and shifts and naturally, training and education at individual and organisational levels.

Smart textiles and monitoring wearables

In a Frost & Sullivan Research Service, Van Cauwenberghe, 2016, introduces the concept of 'smart healthcare' solutions, as a predominant piece under the umbrella of 'smart cities', capable of monitoring the health status of the employees in favour of the early detection of any signs and symptoms and the corrective measures before the effects become irreversible. Indeed, according to another Frost & Sullivan publication, Van Cauwenberghe, 2017, emphasises the role of advanced materials becoming a remarkable and promising field among the foremost innovative areas of medical care at the workplace by synergistically combining principles of intrinsic sensor technology with material engineering.

Ranjan, 2017, in another Frost & Sullivan Research Service, depicts a workplace ecosystem comprising a set of wearables aiming for preventing WRMSDs. A wearable jacket holding sensors in the sleeves can be incorporated to warning about movements, vibrations or harsh

Continued on page 141 →

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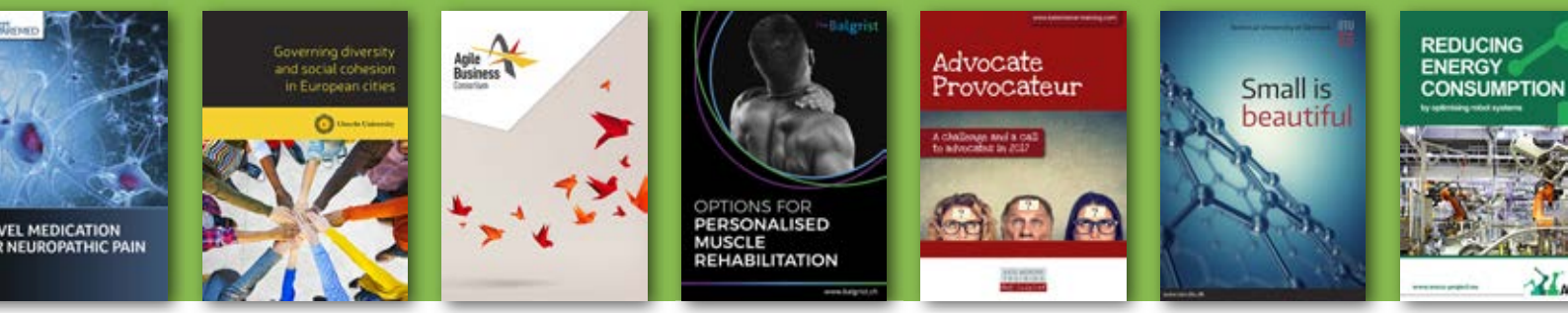

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← *Continued from page 139*

environment via a tactile undershirt to operators. The adaptable mesh network allows each element of the ecosystem to communicate with one another in order to meet plant operator safety guidelines. The main advantages of smart monitoring in preventing WRMSDs are real-time feedback, increased awareness and peer-to-peer communications in the internet of things (IoT) systems, which are expected to significantly boost safe practices. The undershirt can be also designed to monitor the employee's health status in real-time by integrating biosensors to measure heart rate, breathing, skin response, muscle movements and overall spatial position. Pressure sensors included in the insoles of work shoes can help to determine the force applied by the worker and the load on the shoe.

"WRLLDs affect the hips, knees and legs. Among the most commonly recognised, hip and knee osteoarthritis, knee bursitis, meniscal lesions and tears, stress fracture and reaction injury and varicose veins are remarkable. Major causes are related to repetitive kneeling and squatting, fixed postures without a break and frequent jumping. WRLBDs constitute a major health concern in the developed world, involving both low back pain and low back injuries."

The use of emerging sensing technologies at workplace represents a more universal approach to health status monitoring focused on integrating cutting-edge technologies to deal with healthcare data acquisition and their utilisation for WRMSDs prevention. Indeed, vanguard technology innovations play the central role in providing accurate data to be analysed, visualised and shared in real time; thus, improving results. Furthermore, cost-saving and time-effective collaborative relationships among workers, employers, insurers and healthcare organisations, are improving, paving the way for a better health and quality of life for workers.

Acknowledgements

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Further reading

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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.

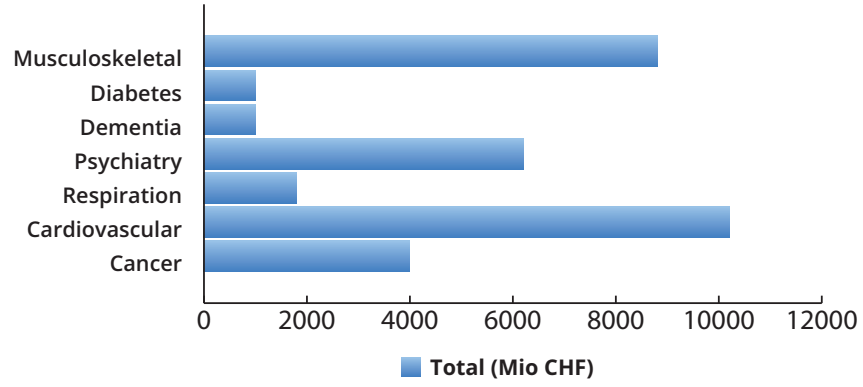

Figure 1: Healthcare costs in 2011 of the seven major non-communicable diseases

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

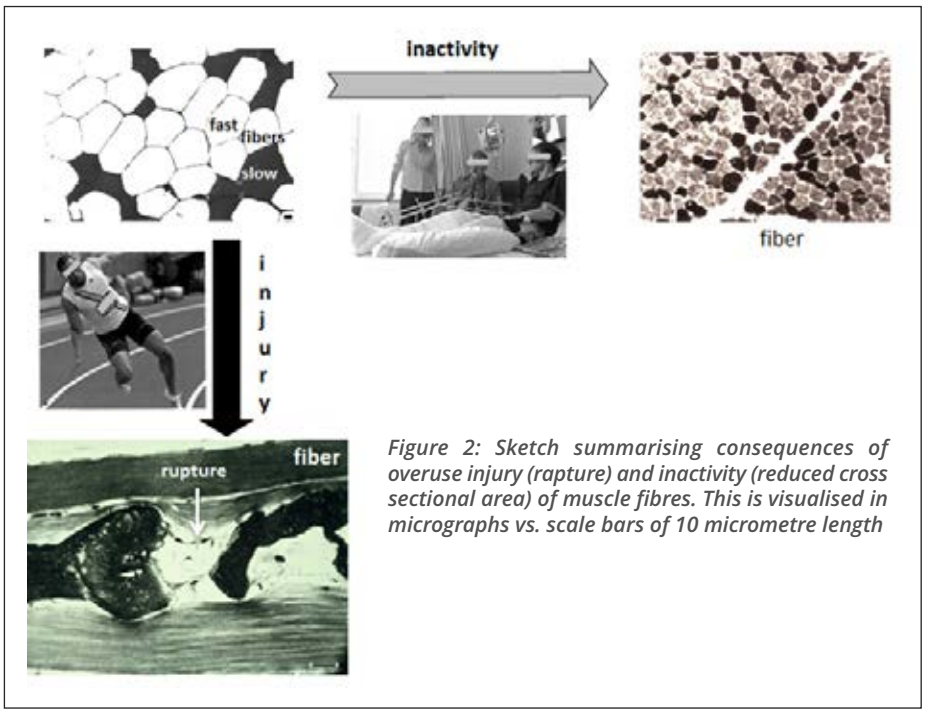

Figure 2: Sketch summarising consequences of overuse injury (rapture) and inactivity (reduced cross sectional area) of muscle fibres. This is visualised in micrographs vs. scale bars of 10 micrometre length

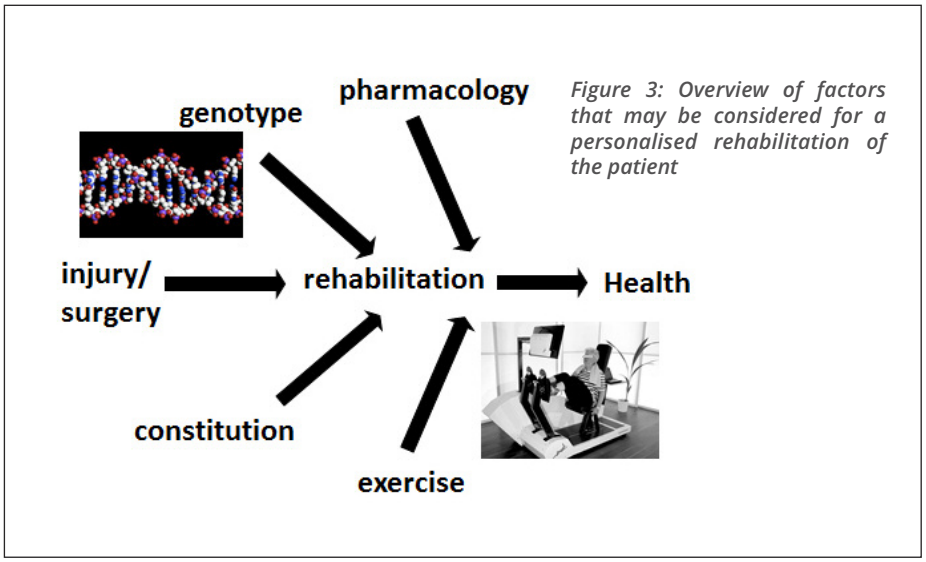

Figure 3: Overview of factors that may be considered for a personalised rehabilitation of the patient

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 polymorphisms 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.

Laboratory for Muscle Plasticity

The Balgrist

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http://balgrist.ch/en/Home/Research-and-Education/Orthopaedics/Muskelplastizitaet.aspx

Cannabis: One of the most thoroughly studied plants ever

David Bearman, M.D., Executive VP of the American Academy of Cannabinoid Medicine details the research priorities for cannabis, one of the most thoroughly studied plants of all time

Cannabis is one of the most thoroughly studied plants of all time. Its documented medical use goes back to the first known materia medical, the Ping Ts'ao Ching, dated by Chinese oral tradition to be written in 2637 BC. At the turn of the 19th to the 20th century, cannabis was the third most common ingredient in physician prescriptions and over-the-counter (OTC) medications, after opium and alcohol. Cannabis was in the USP (United States Pharmacopeia) from the 1850s to 1942.

In more contemporary times, there have been more than 25,000 articles printed in peer-reviewed medical journals on cannabis, cannabinoids and the endo-cannabinoid system, since 1995. Numerous human studies have been performed at four UC medical schools under the administration of the California Medical Cannabis Research Center at UCSD Medical School. Many human studies were done on whole plant alcohol extracted cannabis in the UK from GW Pharmaceuticals. Their tincture of cannabis product, Nabixol, is approved for use in 24 countries including Canada, the UK and the European Union.

Studies

The combination of historical medical use, modern research and clinical experience have demonstrated many of cannabis' therapeutic effects, including analgesic, anti-inflammatory, anti-epileptic and migraine relief. Because of government interference, whole cannabis plant studies in the U.S. are few. We are however beginning to see state and private money supplanting federal government funding of medical cannabis research. Two new academic-based research centres have opened in California, one at UCI School of Medicine and another at UCLA School of Medicine. This is in addition to the Medical Cannabis Research Center at UCSD School of Medicine.

Cannabinoids and terpenes

Over the past three decades, we have been moving into an ever more sophisticated understanding of both the endocannabinoid system (ECS) and the therapeutic constituents of the cannabis (aka hemp) plant. An increased focus is being placed on many of the other 113 cannabinoids found in the plant beside THC and CBD. Research is being done on THCa, CBDa, THCV, CBC, CBN, CBG and other cannabinoids. For instance, the existing research shows CBC has anti-inflammatory and anti-cancer properties.

Terpenes are the most common molecule in nature. There are more than 200 terpenes in the plant and they have got the attention of researchers. Cannabis terpenes include B Caryophylin, Pinene, Humulene, Myrcene, Linalool, Limonene and Nerolidol. Not only will more research be done on the role of these cannabinoids and terpenes, but studies have and will look at not only the THC/CBD ratios but also the therapeutic contribution of many of the other constituents of the plant, such as those mentioned above.

Health

Allopathic physicians are experts in disease not health. Cannabis has been called a food, a vegetable and a nutraceutical. The seeds are high in Omega 3 and Omega 6 fatty acids and cannabis may decrease the risk of certain cancers. We need to study what the daily minimum dose of cannabis should be recommended.

Medical conditions and cannabis treatment

As to looking at cannabis' therapeutic utility for specific disease entities, we have over 4,000 years of clinical use to suggest what conditions to look at. To date, most of the modern studies have looked at the low hanging fruit; treating nausea, epilepsy, pain and for appetite stimulation. A ground-breaking study on

cannabis for post-traumatic stress disorder (PTSD) is being carried out in Arizona right now with 76 military veterans by Dr Susan Sisely. With 22 American military veterans committing suicide each day and the VA ignoring the potential benefit of cannabis for treating PTSD, this is an enormously important study.

"As to looking at cannabis' therapeutic utility for specific disease entities, we have over 4,000 years of clinical use to suggest what conditions to look at. To date, most of the studies have looked at the low hanging fruit; treating nausea, epilepsy, pain and for appetite stimulation. A ground-breaking study on cannabis for post-traumatic stress disorder (PTSD) is being carried out in Arizona right now with 76 military veterans by Dr Susan Sisely."

Another related area is ADD (attention deficit disorder) /ADHD (attention deficit hyperactivity disorder). ADD/ADHD often has a genetic component however it can also be a co-morbid condition with PTSD. There have been well over 75 studies done on cannabis and cannabinoids for the treatment of the symptoms of ADD/ADHD. Prominent researchers, such as Dr Danielle Piomelli at UC Irvine have done ground-breaking work on the benefits of cannabis and cannabinoids for treating this condition and more work continues.

Does cannabis "cure" cancer?

The most important question to answer is, does cannabis cure cancer? Donald Abrams, MD, oncologist and professor at UCSF School of Medicine, has said that there is more than enough basic scientific evidence and anecdotal reports to justify doing double-blind studies to see if cannabis cures cancer. The first such human study was completed last year in the UK on glioblastoma (GBM). With a very low dose of a whole cannabis plant alcohol extract (25 mg. THC, 25 mg. CBD administered three times a day), the study documented a 40% increase in lifespan from diagnosis to death for those receiving conventional treatment plus tincture of cannabis as opposed to conventional treatment alone (330 days compared to 510 days). Clearly, more studies with higher doses of THC and CBD need to be done not only on glioblastoma but also on multiple types of cancer.

Dose and THC/CBD ratio

Researchers and clinicians are still trying to determine what the appropriate dose of THC and CBD is, as well as what role, if any, other plant constituents play in treating the many medical conditions that respond favourably to cannabis. With the federal government sitting on their hands, it is important for state governments and private interests to fund cannabis research that could prove to be critical to potentially life-extending discoveries.

Endocannabinoid system (ECS)

Lastly, we need another article to cover the studies required to learn more about the ECS. As a clinician, I leave that article to basic science researchers. The ECS plays a key role in neuromodulation and homeostasis. Because of the ECS's impact on most organ systems, there are an enormous number of disease types which are ripe for more research on cannabis' therapeutic value. These conditions include but are not limited to, neurodegenerative disease, autism spectrum disorder, bipolar disorder, autoimmune diseases, connective tissue disorders, gastrointestinal disorders, as well as the well-known conditions of migraine treatment, seizure disorder, analgesia PTSD, ADD/ADHD and cancer. A better understanding of the ECS is giving us new insight into the functioning of the human brain and immune system.

I invite state, federal and private resources to help us better understand the human body to develop better, more effective prevention and treatment of disease. ■

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Mental health care and the pharmaceutical industry

Marcin Rodzinka, Project Coordinator at Mental Health Europe explains how transparency between the pharma industry and health professionals can influence the quality of mental health care in Europe today

Mental health care is one of the most influenced sectors by the pharmaceutical industry. Every year, a plethora of new medication and treatments are introduced to the market and to mental health professionals. While the progress and evolution of new treatments may be helpful for some people living with mental ill health, they should not be considered unique or automatic solutions for everyone experiencing mental distress. Taking a pill will never be a substitute for integrated mental-health care and support and that is why it is crucial to ensure relationships between the industry and doctors are transparent and irreproachable.

Cooperation between the 'Big Pharma' and healthcare practitioners often involves financial flows or agreements where a few grey areas remain. Recent research has highlighted that receiving even small items funded by the industry, such as free meals or goodies, were associated with an increased rate of prescribing for the medication being promoted. This is concerning since it may lead to over-prescription and overuse of certain medications which might not always be required.

Over the years, the pharmaceutical industry has undoubtedly played an important role in putting drug treatment at the centre of modern psychiatry. Its powerful influence is not only rooted in its ties with health professionals but also through pharma-funded research, which is more likely to find favourable results to drug treatments. Yet, recent and controversial research has underlined that the benefits of antidepressants and antipsychotics tend to be overemphasised and some of the risks poorly reported.

Relationships between the industry and doctors are important, providing they remain healthy and transparent and focused on patients' health. Biased research results and unbalanced relationships, on the other hand, may reinforce a narrow biological conception of the nature of mental ill health which understates the adverse effects of psychiatric drugs.

Patients' choices and quality of care should be at the centre of any treatment

Mental ill-health cannot be considered as a disease or illness caused by purely biological or neurological factors: it is important to look at a person's life and social environment, treating these factors as equally important in understanding both well-being and mental ill health. It is now widely acknowledged that appropriate mental health care cannot solely be based on medication: integrated mental health care must look first at the root cause of a problem and an experience rather than trying to treat the 'symptoms' only with medication.

"Over the years, the pharmaceutical industry has undoubtedly played an important role in putting drug treatment at the centre of modern psychiatry. Its powerful influence is not only rooted in its ties with health professionals but also through pharma-funded research, which is more likely to find favourable results to drug treatments."

However, the lack of transparency between pharma and healthcare providers may lead to situations where not enough consideration is given to informed consent of people seeking professional help for their mental health, alternatives to medications and the possibility of discontinuing medications. A survey published in The Journal of Law, Medicine & Ethics has shown that 52% of patients would like to know whether their practitioner has a financial relationship with the pharmaceutical industry. Surveys like this show there is real demand and concern for transparency in healthcare.

The transparency issue in mental health care is a particularly crucial one. Without transparency, there could be a lack of fully informed choice for doctors and patients, over-medicalisation of mental health and a worrying reliance on drugs as the main form of treatment for mental ill health.

Our vision of effective and appropriate mental health care should not be shaped by the marketing budgets and interpretation of results of pharmaceutical and medical technologies (MedTech) industries. It is encouraging to see that some countries have decided to address the issue by adopting and implementing sunshine and transparency laws, regulations, or codes across Europe. This paves the way for more harmonised and transparent relationships between the industry and healthcare professionals.

Independent health professionals informed and empowered patients, as well as transparent and collaborative relations between the pharmaceutical industry and the mental health sector, are key elements to ensure adequate and appropriate healthcare, which places patients at the centre of the process. ■

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A postcard showing a canopy bed: An ex-user of mental health services shares his story

In an interview, Franz-Josef Wagner tells Elena Posth from Pfalzklinikum AdöR about his experiences as an ex-user of mental health services in the Rhineland-Palatinate region of Germany

Franz-Josef Wagner is the chairman of the state association of (ex-)users of mental health services in Rhineland-Palatinate (formerly LVPE, now NetzG), the regional association for self-help in mental health in Germany. From the very beginning he has been involved and in 1996, the year of its foundation, he was first vice chairman. Here, Editor at Pfalzklinikum, Elena Posth talks to him about his various tasks and the messages he wants to convey.

Mr Wagner, how did the foundation of the LVPE come about?

Franz-Josef Wagner: The state law concerning mentally ill persons introduced in 1995 formed the basis of LVPE's foundation. In it, particularly, the co-operation of mentally ill persons and the precedence of self-help over public help were pointed out. In May 1996, three chapters were merged to form the state association of (ex-) users of mental health services in Rhineland-Palatinate. The first chairman in those days was Winfried Krolla. I took over his position in 1999.

You have built up a new network organisation. What did you plan exactly?

Franz-Josef Wagner: The Federal Network Self-Help Mental Health (NetzG) was founded in November 2016. Until recently, it has not been registered, there were some formal problems. In May 2017, we had our second general meeting. In future, we want to voice our opinions regarding amending laws, we want to have a say and represent our interests at the political level. So far, self-help groups have only offered their services. We want to change this. We want to monitor and control services by means of evaluations, for example, and to bring up a painful subject in the interests of all those concerned.

And what has changed in the state association?

Franz-Josef Wagner: Before the reorganisation, the complete work of the state association was split up between three persons. I, for myself, had more than 80 dates outside our office in Trier last year – without counting those in my surrounding area – I worked for more than 1,900 hours. To change this situation, we contacted a

business consultant for help. She advised us free of charge. Together with us, she reflected on the questions of what structure and name we should have in future, especially since we had no organisational or content-related contacts to the federal association of (ex-)users of mental health services. The new orientation of the LVPE is inspired by NetzG, the federal network of self-help in mental health. The problem is that most of our members do not want to work politically or give their name in general. This clearly shows that the stigma around mental health is still a very present one.

What forms of participation do you ask for? Are there good or bad examples?

Franz-Josef Wagner: I think, the Pfalzklinikum's initiative "The Palatinate makes itself/you strong – ways to resilience" is a very good example. It is a project with good publicity and participation. Looking at the development of this over last few years, I think that we are heading in the right direction. The World Congress of Psychiatry in October 2017 in Berlin mirrored a change in science: now an individual's subjective experience is important for objective research.

This gives meaning to psychosis. Some of my essays describe four different stages of my life: the normal phase; resignation; convalescence and the recovery phase.

In the second phase, the stage of resignation, I simply stayed in bed for 22 to 23 hours. This phase lasted for four to five years. In my case, convalescence was triggered by my daughter. One day she sent me a postcard showing a canopy bed and straight away I knew that my children were informed. However, I wanted to be a good dad and not just stay in bed.

Therefore, I decided to go cooking. In the beginning, my most difficult decision was to select a pack of rice when shopping. I said to myself: "You do not go back, you make a decision" and I trained this regularly. It can be compared to school: When you are in first class, you cannot pass your A-levels immediately. You must practice. It is the same in life.

Since when has there been a cooperation with Pfalzklinikum and how do you evaluate it?

Franz-Josef Wagner: In my opinion, the cooperation with Pfalzklinikum is very good. Prior to CEO Paul Bomke, it was zero, the medical directors did not accept us. They were simply not prepared yet. But since 2012, a very close, human and honest cooperation and communication between us has developed. Now, we have many interesting common projects, for example, EX-IN, recovery and symposiums.

What are your messages in life?

Franz-Josef Wagner: I know that I have just one life and I want to enjoy it and live in a simple way. I am grateful for every day I get up and am still alive. Previously, I found myself in a giant tunnel without any light at the beginning or the end, in the void. Today I have overcome everything. I live with a feeling of pure happiness. For me, the inner drive, the intrinsic motivation plays an important part. At first, I did not have it. I find it important that the persons concerned get more guidance from professionals. On your own, it is very hard to find a sense of direction.

What are your objectives or dreams in self-help?

Franz-Josef Wagner: My dream is to carry out quality checks by means of evaluation and to ensure that many users and ex-users of mental health services find a job in the labour market. However, I do not want to award a TÜV stamp to organisations. Instead, I want to accept the existing system and do not want to make it exclusive.

What do you do when you have spare time?

Franz-Josef Wagner: I love hiking. For (ex)-users of mental health services, the communication with the external world is very important. For this reason, I am a member of the Trier chapter of the "Eifelverein" hiking club; I enjoy their inclusion of my deficiencies. There, I take over organisational tasks and promote interpersonal relationships. Hiking can strengthen and change one's personality.

Another hobby is cooking. Every day I prepare my meals, once a week together with another (ex-)user of mental health services. We choose a three-course meal costing approx. €6 per day, buy the food, cook, eat and do the washing up. My favourite meal is spaghetti with German caviar. I created this appetising combination myself!

Die Pfalz macht sich dich stark.
WEGE ZUR RESILIENZ.

Pfalzklinikum

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The role of research in Canada for the future of ageing

Dr Yves Joanette, Scientific Director at the CIHR Institute of Aging explores how Canada's researchers are meeting the needs of an ageing population, now and in the future

The world's population is ageing. The World Health Organization projects that the number of people of over 60 will double by 2050. Dr Margaret Chan, former Director General of WHO noted it is not enough that people are living longer lives, we need to ensure these extra years are healthy, meaningful and dignified.

As Scientific Director of CIHR's Institute of Aging, I couldn't agree more. We want to make sure that these extra years are functionally healthy, that older people continue to lead meaningful lives and that they are treated with the utmost dignity and respect.

In Canada, we reached a major demographic inversion in 2016. For the first time, the number of Canadians aged 65 and older surpassed the number of Canadians aged 14 and under. That trend is expected to continue with one in four Canadians expected to be aged 65 or over by 2036, thus bringing Canada among the super-aged countries.

The fastest growing segment of our senior population is the 'oldest old' – or people 85 years old and more, with centenarians being the most rapidly growing group.

This increased lifespan results from the excellent quality of life in Canada. It also results from access to high-quality healthcare and the success of our public health programmes. To adjust to this demographic change, it also means that we need to change our social programmes and attitudes towards older people.

In Canada, we have long anticipated this demographic change and from a research perspective, we have worked to establish the infrastructure needed to carry out collaborative research among researchers and institutions within Canada and internationally.

Our first step was to establish an Institute of Aging as part of the Canadian Institutes of Health Research in 2000. I've had the privilege of serving as Scientific Director of the CIHR Institute of Aging since 2011 and our mission is to support research, to promote functionally healthy ageing and to address causes, prevention, screening, diagnosis, treatment, support systems and palliation for those complex health challenges that can be present in older individuals.

"This increased lifespan results from the excellent quality of life in Canada. It also results from access to high-quality healthcare and the success of our public health programmes. To adjust to this demographic change, it also means that we need to change our social programmes and attitudes towards older people."

To provide critical data on the determinants of functionally healthy ageing, we fund the Canadian Longitudinal Study on Aging (CLSA). This cross-Canada research platform involves more than 50,000 Canadians, aged 45 to 85, who will be followed for 20 years. CLSA will provide data and biological samples for Canadian researchers to help identify the determinants of a functionally healthy ageing, from the most basic biological to the most social aspects, including work and retirement trajectories.

The CLSA team recently released a first baseline report. It represents the most comprehensive picture of the health of Canadians over age 45 ever produced. On the bright side, almost 90% of participants rated their health as good to excellent. At the same time, the report revealed potential challenges. Only 25% of participants reach recommended amounts of physical activity. 38% of participants reported having to provide care to

others. And among retired participants, 25% reported health reasons as a factor in their decision to retire.

> "In Canada, we reached a major demographic inversion in 2016. For the first time, the number of Canadians aged 65 and older surpassed the number of Canadians aged 14 and under. That trend is expected to continue with one in four Canadians expected to be aged 65 or over by 2036, thus bringing Canada among the super-aged countries."

Finally, loneliness and social isolation, particularly among women, was identified as a concern. If we want to break down barriers that prevent older adults from continuing to work or otherwise lead fulfilling lives, we will also have to embrace new technologies in ways that will support the mobility and independence of older people.

As we look forward to the future, the Institute of Aging is committed to creating a world that supports health and wellness throughout the trajectory of ageing.

Overall, we want to celebrate and help older adults to participate fully in their communities and to contribute their skills and wisdom to their families, friends and fellow citizens. ■

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Physical activity and ageing: Recommendations that will translate into greater practice

Isabelle J. Dionne, Professor at Université deSherbrooke provides a compelling analysis of physical activity (PA) and ageing, focussing on how to develop recommendations that will translate into greater practice

Physical activity (PA) is a key behaviour in the determination of health and quality of life. Despite massive public health strategies and clear recommendations, physical inactivity remains elevated in developed countries. Increasing the levels of physical activity depends upon innovative and effective avenues of PA promotion.

Physical activity and ageing

The overall objective of the Canada Research Chair is to improve older adults' quality of life and health by determining the best exercise modalities, accompanied or not by nutritional interventions, to prevent or delay T2D or disability (loss of physical function). Indeed, the ageing of the population and the greater prevalence of obesity at all ages leads to major health issues, among which Type 2 diabetes (T2D) and physical disability have important clinical implications. Both conditions could be prevented by the development of specific exercise recommendations.

While the Canadian Society for Exercise Physiology guidelines promotes a minimum of physical activity participation to improve health in the general population: they do not target precise medical conditions or affected populations who may benefit from more specific recommendations. Learning from exercise physiology and performance studies, we know that depending on the exercise type (aerobics, resistance), modalities (number of repetitions or duration of bouts) and intensity (percentage of maximum capacity – heart rate, maximum oxygen consumption, percentage of maximum strength), we can generate specific metabolic and functional adaptations. Hence, specific exercise recommendations could be developed to minimise the risk of developing diseases such as T2D or disability in older individuals who have been identified to be at risk.

Within the past 10 years, the Faculty of Physical Activity Sciences, together with the Research Centre on Aging, has developed a strong expertise in conducting large exercise trials with tight control of the intervention and a wide array of clinical areas, which is instrumental in developing exercise recommendations. Research in this area is especially timely since the high prevalence of physical inactivity and disuse in older adults has led to numerous health problems. In parallel, a surge of research on adherence to physical exercise in all populations focusses on making older adults, among others, to adopt an active lifestyle. It thus appears timely to intensify research not only on the importance of doing it but also on what to do based on the specific health needs of an individual.

The specific case of Type 2 diabetes

Type 2 diabetes (T2D) remains a major chronic disease in Canada and clinical practices need to be revisited for both prevention and management. For instance, gains in muscle mass are still promoted to be associated with improvements in insulin sensitivity. Nevertheless, we found that a small in size, but high-quality muscle mass seems beneficial to cardiovascular risk factors, such as blood lipids and glucose metabolism. Surprisingly, we even showed that during exercise, muscle mass loss was beneficial for insulin sensitivity, possibly through improvements in inflammation and quality. My work thus supports to explore creative strategies where weight loss would be accompanied by changes in muscle mass quality, instead of absolute gains and examine how it would impact metabolic impairments, especially those that will have been determined to increase the risk of T2D in older women with a family history of it.

On the other hand, the level of exercise remains low in adults with health risk and in diabetic patients. In our

lab, older women tend to reduce exercise practice, even after having been supervised for several months and having experienced tangible benefits. We thus intend to extend exercise recommendations to the context of practice and recently began studying exercise adherence using more ecological approaches (i.e. living lab). For instance, my team and I have developed an interest in why people struggle with engagement and compliance in exercise programmes, despite wide education strategies. We thus conducted studies pertaining to personal and contextual factors of exercise practice to determine how to increase exercise programmes adherence and compliance over time. We determined that adherence to exercise programmes is greater outdoors than indoors, with equivalent physiological responses. These results are important because we also showed that current exercise participation is the best predictor of health in older adults, independent of past participation or not. These results allow refining recommendations, by adding key pieces of advice related to the context of exercise practice for older adults.

The need for interdisciplinarity research

In this context, the importance of interdisciplinary research has become evident. Numerous contemporary health problems can be blamed on physical inactivity (a level of physical activity of moderate and vigorous intensity that is below recommendations) and sedentarity (many sedentary activities such as TV watching, computer-based activities, reading, etc.). This applies to several populations (children, adults and elderly) in various contexts (leisure, school, working environment, long-term care facilities, etc.).

Altogether, these complex problems call for more comprehensive strategies supported by a large array of perspectives (physiological adaptations, contraindications, motivation, health education, etc.). Interdisciplinary research, in that sense, appears as one highly pertinent avenue. In this line, the Faculty of Physical Activity Sciences has recently launched the first Doctorate Program in Physical Activity Sciences that is interdisciplinary in nature. We are confident that this type of training will support the training of future researchers who are more open to addressing physical inactivity and its health complications through a wider spectrum of approaches and the most appropriate methodology.

The ultimate goal

Our research will inform clinical guidelines through creative exercise recommendations, both from a prescription (type, intensity) and contextual (setting, environment) standpoints. My research will improve exercise efficiency, adherence and maintenance, leading to a decreased overall risk of developing T2D and related disability, thus contributing to improve older women's health.

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Greater research investment is needed for a dementia breakthrough

Dr Doug Brown, Chief Policy and Research Officer at Alzheimer's Society, discusses why more investment is needed in dementia research

Dementia is the biggest health and social care challenge we face. In the UK, there are 850,000 people living with dementia – this number is set to rise to over 1 million by 2021. It's a condition that affects 1 in 6 people over the age of 80, yet dementia research remains vastly underfunded when compared to the huge economic cost of the condition.

The term dementia is used to describe a set of symptoms, triggered by diseases of the brain, which cause a loss of brain function. Everyone experiences dementia differently but some of the most common symptoms include memory loss, confusion and difficulties with speech and understanding. Often, the changes tend to start small but gradually get worse becoming severe enough to affect daily life. Of the top ten causes of death, it is the only condition that we can't cure, prevent or slow down.

It is only through research that dementia can be fully understood and defeated – but up until recently research into dementia has been largely neglected. A study by Oxford's Health Economics Research Centre revealed that research investment into cancer was thirteen times higher than investment in dementia research. It is vital that dementia research receives the level of investment that matches the economic and human cost of the condition, which is currently estimated to be £26 billion a year in the UK.

While we are taking steps in the right direction with global political commitments and increased government funding for dementia research, studies into care have lagged behind biomedical research. The largest consultation of people affected by dementia, 'Turning up the Volume', revealed that people living with the condition want to see this change, with the report highlighting that dementia patients currently don't get the same quality of care from health and social care services. Until a cure and better treatment options are developed, it is, therefore, critical to explore and invest in dementia care on an equal footing with biomedical research.

Alzheimer's Society is a world leader in biomedical research with programmes ranging from understanding the molecular basis of the diseases that cause dementia through to our ground-breaking drug discovery programme. In addition, Alzheimer's Society is leading the way in rebalancing investment between biomedical and care research and just this last year awarded £5.6 million to three Centres of Excellence across the UK – our biggest ever single investment into dementia care research. The three Centres of Excellence will focus on the following three priority areas over the next five years:

1. Developing a better understanding of what it means to live well with dementia

It is crucial that people with dementia are able to live well and have a good quality of life – yet little is known about how to improve quality of life for people with dementia.

The project, 'Improving the experience of Dementia and Enhancing Active Life' (IDEAL), led by Exeter University, aims to identify what factors help someone to live well with dementia and what affects their quality of life as their condition develops. The study is made up of 1,570 people with mild to moderate dementia, 50 people with advanced dementia and 1,300 carers enabling the researchers to gain a deep understanding of their experiences of living with dementia over a six-year period. The findings will be used to understand what strategies and initiatives can be put in place to improve the quality of life for people with dementia and how changes to policy, healthcare practice and the provision of services can help.

2. Improving support after a dementia diagnosis

Recent investigations have highlighted the disparity of support that people with dementia have received after a diagnosis, including Alzheimer's Society's 'Dementia 2015' report.

Seeking to improve the quality of care and support people with dementia receive, Newcastle University's 'Primary care-led post diagnostic Dementia care' (PRIDEM) project is aiming to develop and evaluate suitable, feasible and sustainable models of care, which are centred on the person receiving the dementia diagnosis. Working in close partnership with local health and care service providers, as well as people living with dementia and their families and carers, the researchers will explore their experiences of support after a diagnosis. The aim is to develop models that will detail how support after a diagnosis will be led by primary care services such as community-based services and GPs.

3. Exploring better ways to support people with dementia to live independently in their homes

Most people with dementia want to remain living in their own homes for as long as possible, often they are able to do this aided by home care workers or family carers. However, Alzheimer's Society's Fix Dementia Care campaign found that only 2% of people affected by dementia believed home care workers had sufficient dementia training. This lack of training can cause relationships to break down and severely affect the care of the person with dementia.

The University College London (UCL) aims to tackle this break down in care by developing a better understanding of how independence at home can be improved for people with dementia. Through their 'New interventions for Independence in Dementia' project (NIDUS), the university will work with people affected by dementia, carers and home care workers to develop training on how best to care for a person with dementia. This evidence-based programme will develop a cost-effective way to improve care at home, whilst guaranteeing that professional carers receive much-needed training in dementia care and help family carers to reduce stress and improve relationships.

> "Dementia is the biggest health and social care challenge we face. In the UK, there are 850,000 people living with dementia – this number is set to rise to over 1 million by 2021. It's a condition that affects 1 in 6 people over the age of 80, yet dementia research remains vastly underfunded when compared to the huge economic cost of the condition."

Research will beat dementia – but more funding is needed. Local health and social care services are faced with many complex issues, as well as limited resources. To offer the highest standard of care, commissioners rely on research and evidence-based practice. The Centres of Excellence are building this evidence base in the area of dementia care – and making it available to policy-makers and practitioners.

This is the first step towards improving the lives of people with dementia but investment is vital if we are to continue delivering real change for people affected by dementia. ■

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An update on exports in the health technology sector

Jonathan Evans, communications manager at the Association of British HealthTech Industries provides an interesting update on the health technology sector, including the extent to which the UK exports to the EU every year in this vein

Whatever side of the debate you stand on, one thing is for certain, post-Brexit trading relationships must be right for UK patients. This has come into sharp focus of late.

After an analysis of HMRC's UK Trade Info database, we at the Association of British HealthTech Industries (ABHI), highlighted that the significant majority of health technologies that are used by the NHS come from the EU.

Of the £5 billion total used by our health system in 2016, £3.2 billion came directly from the European Union and our reliance on this source, as a country, has also increased by 20% in recent years.

International supply chains are complex for many industries and this is no different within the HealthTech sector. Our sector is broad and diverse. It is made up of single-use devices, orthopaedic implants, cardiac stents, digital monitoring devices and thousands of other products in between. It is, in short, complex. Products will cross the UK and EU border many times in the lifecycle for sourcing, assembly, sterilisation and packaging. At present, this cross-border process is frictionless, however, any disruption or delay to this process could pose a significant risk to patients if not correctly managed.

The nature of these supply chains also means that even goods manufactured in the UK are often, ultimately supplied to the NHS from distribution centres in the EU. Delays in getting goods across borders are obviously problematic; 20% of products used in procedures where they are the main part of the procedure, for example, a cardiac implant, are delivered next day from the EU. If the UK becomes a difficult place to ship to, companies will de-prioritise the UK as a market, so products won't be available.

As a country, the UK also exports around £2 billion of health technologies to the EU every year. The same delays and disruptions pose a threat to the health of patients throughout Europe. It is why we as an association are calling for all products used in healthcare to be exempt from any new customs, tariff or VAT arrangements, and afforded pre-shipping clearance and fast track access across any new EU/UK borders.

The above points do not only affect industry but, of course, pose a significant threat to public health across Europe. Delays and disruptions caused by a no or poorly negotiated agreement as it relates to the supply of health technologies will be felt most quickly and most acutely by those patients and healthcare systems that depend on them. The issue really is that critical.

Yet Europe, as a place to do business for UK companies, is still very much the foremost market for our members. Indeed, a recent ABHI membership survey revealed that 70% of UK companies expect their exports to Europe to increase in 2018. This is higher than any other market. Once again, highlighting the need to manage Brexit correctly, to ensure the trading opportunity that Europe represents is not lost. ■

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Transmission Kikuchi diffraction (TKD) in the scanning electron microscope (SEM)

Alice Bastos da Silva Fanta, senior researcher at the Center for Electron Nanoscopy explores the world of Transmission Kikuchi diffraction (TKD) in the scanning electron microscope (SEM), a technique, she argues, that came to stay

The microstructure and composition of a material influences its properties and consequently, its applications. At the same time, the microstructure of a material is influenced by the fabrication method and process. Furthermore, it can change during operation, due to, for example, environment or process changes. New technology development needs to be in close relationship with microstructure characterisation and understanding. Numerous techniques to study materials microstructure and composition exist and in general, only the combination of them enables the required understanding of the microstructure.

One technique commonly applied when characterising crystalline materials is electron backscatter diffraction (EBSD), which is an electron microscopy technique used to obtain quantitative information from crystalline samples in a scanning electron microscope (SEM). The diffraction patterns backscattered from small volumes close to the surface of a flat sample are automatically indexed as the electron beam scans the sample. The characteristic diffraction patterns allow for a reconstructed crystal orientation map of the sample. EBSD is a powerful technique to study size, shape and distribution of grains and grain boundaries, in addition to local crystal orientation and misorientation of the sample. It can be combined with other techniques, such as energy dispersive X-ray spectroscopy (EDS) for elemental analysis, or a focused ion beam and is widely used in many research fields and industries to characterise microstructure and texture.

> "Since the TKD technique is relatively new, it is natural that there is room for improvements, therefore, our future efforts in the field will focus on improving detection capability to enlarge and improve the application field of the technique."

Although EBSD is applied extensively

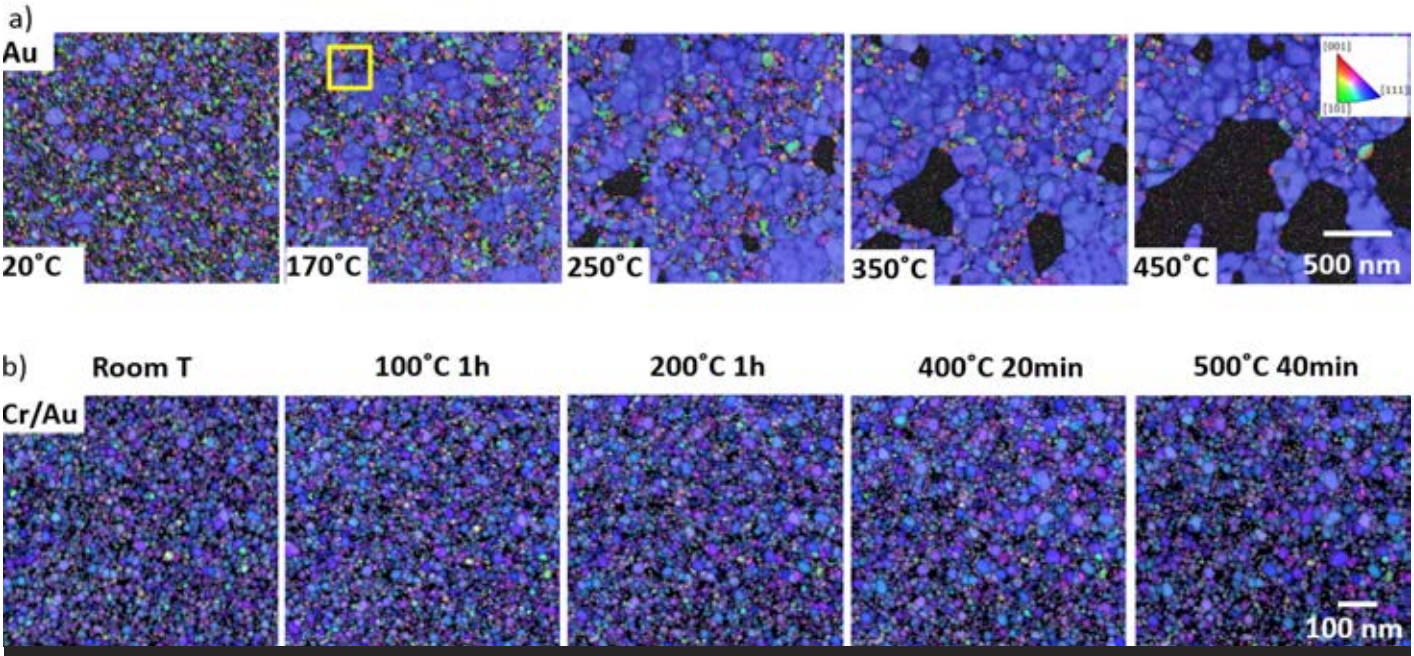

Figure 1: (a) Inverse pole figure z-direction (IPFZ) TKD maps at selected temperatures of a 20nm Au film, showing grain growth and the formation and growth of holes in the film. The first hole is formed already at 170°C (yellow square). (b) IPFZ maps showing the morphology evolution with temperature of a 2nm Cr/20nm Au bilayer system. The Cr adhesion layer prevents grain growth and dewetting of the Au layer up to a temperature of 500°C.

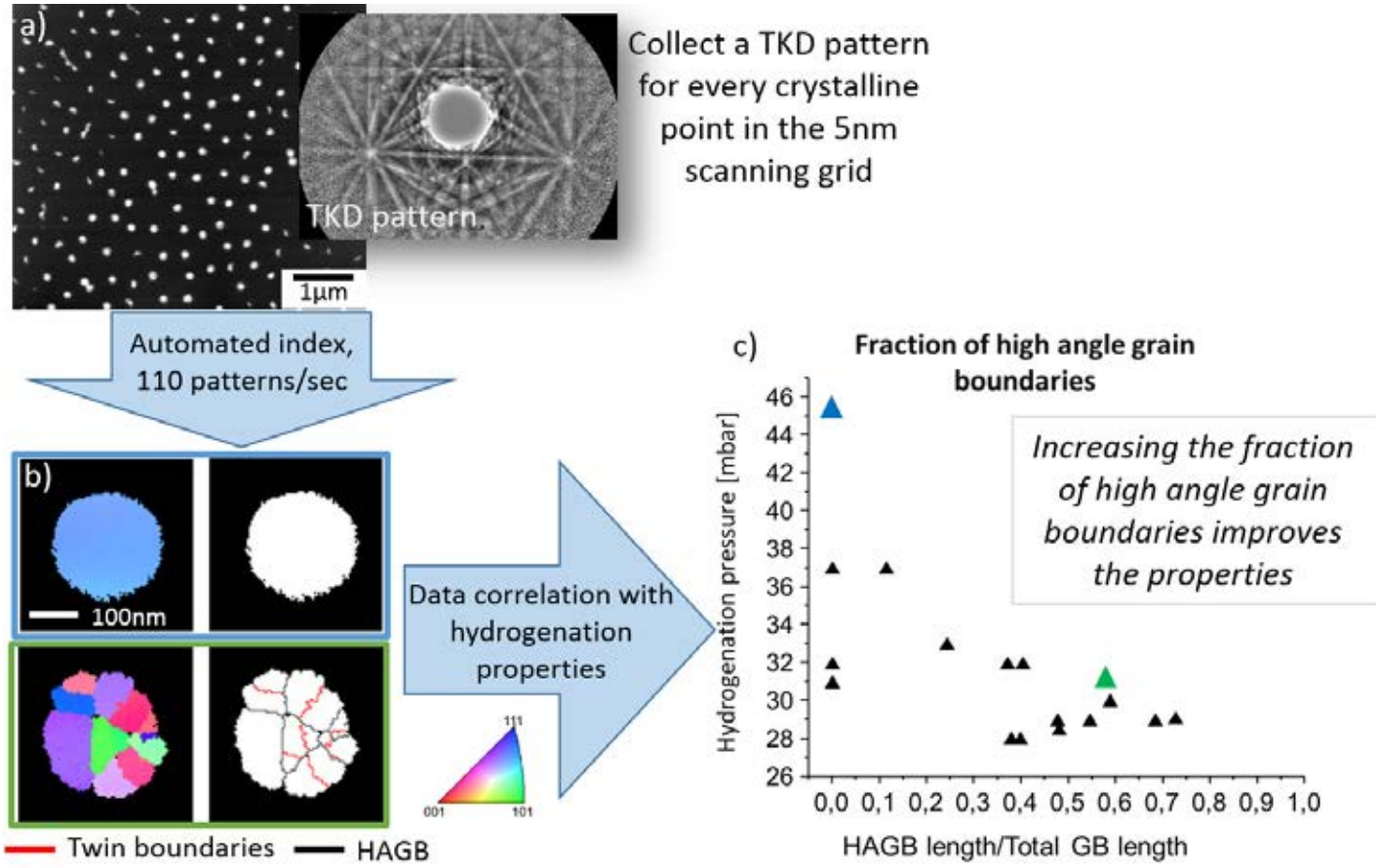

Figure 2: Correlation of single Pd nanoparticle microstructure with hydrogenation properties. (a) Scanning transmission electron microscopy image (STEM) (b) Orientation map revealing the crystal orientation parallel to the growth direction for two single particle showing high angle grain boundaries (HAGB) in black and twin boundaries in red and (c) correlation between hydrogen uptake pressure and fraction of high angle grain boundaries of single particles.

for linking process, structure and properties of materials and minerals, its spatial resolution is insufficient to truly characterise nanoscale materials. This class of materials has been traditionally investigated using transmission electron microscopes (TEMs). However, thanks to the recent work of Keller and Geiss[1], an alternative way of studying electron transparent samples with an EBSD detector was proposed and the application of EBSD could be extended to nanocrystalline materials. Although this new approach was first called t-EBSD (for transmission EBSD), it is now known as transmission Kikuchi diffraction (TKD).

The improvements in spatial resolution make it comparable with diffraction mapping techniques in the TEM. Considering the flexibility, the accessibility and the relatively simpler operation of a SEM in comparison to TEM, TKD has potential to become as widely applied in nanocrystalline material characterisation. Furthermore, as SEM operates at lower energy ranges than TEM, TKD can be an alternative technique to explore and investigate electron beam sensitive crystalline materials.

At DTU Cen, we focus on developing, exploring and applying TKD to correlate microstructure with properties of low dimensional nanocrystalline materials. In this light, we study nanowires, nanoparticles and thin films with TKD[2–5], optimising sampling conditions[6], performing dynamic experiments[7] and improving detection capabilities.

> "New technology development needs to be in close relationship with microstructure characterisation and understanding. Numerous techniques to study materials microstructure and composition exist and in general, only the combination of them enables the required understanding of the microstructure."

Solid-state dewetting is a phenomenon in which a continuous film agglomerate at elevated temperature forming particles. The importance of understanding the microstructure

features influencing this process is two-fold: firstly, avoiding the film breakdown during device operation is essential to ensure functionalities, and secondly, this phenomenon can be employed as an effective tool for fabricating ordered nanoparticle arrays which find applications in, for example, optical devices. Figure 1 (a) shows a series of TKD maps revealing a gold film of 20 nm starts dewetting already at temperatures below 200°C, under 50 Pa water pressure[7]. Such temperatures are easily achieved during device fabrication and operation. Changing the environment, or adding an adhesion layer, influences the extent of dewetting, as shown in Figure 1(b). A fundamental understanding of the starting point of the dewetting process is essential in order to predict and control the microstructure to avoid dewetting, or to tailor the dewetting depending on the application of interest.

TKD investigation of palladium nanoparticles used in hydrogen sensing devices, reveals that particle microstructure is significant for the hydrogenation and dehydrogenation properties. The correlation of the quantitative data obtained by TKD with the single particle plasmonic response allows us to distinguish the key microstructural feature influencing the hydride formation and decomposition which is directly related to the hydrogen sensing properties of the nanoparticles (Fig. 2)[4]. The fundamental understanding of the microstructure and its role on the particle properties enables the control and design of improved hydrogen sensors; essential for developing a hydrogen economy, since hydrogen is highly flammable in air, and for safety reasons, any leaks must be immediately detected.

"At DTU Cen, we focus on developing, exploring and applying TKD to correlate microstructure with properties of low dimensional nanocrystalline materials. In this light, we study nanowires, nanoparticles and thin films with TKD[2–5], optimising sampling conditions[6], performing dynamic experiments[7] and improving detection capabilities."

These examples highlight the potential of TKD for nanoscale characterisation and for studying structure – functionality relationship. The methodology applied to these examples is well suited for many other systems and platforms and it can be predicted that it will be widely employed in the near future. Since the TKD technique is relatively new, it is natural that there is room for improvements, therefore, our future efforts in the field will focus on improving detection capability to enlarge and improve the application field of the technique.

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Making innovation happen in Europe

Martin Kern, Interim Director at the European Institute of Innovation & Technology (EIT), a body of the European Union, tells us about making innovation happen in Europe

The problems the world faces are well documented. Climate change, for example, will exacerbate the scarcity of resources. This influences food, water and energy supply and affects health and national security.

The European Institute of Innovation and Technology (EIT) was set up to find solutions to such challenges and this is exactly what we deliver. We do this with tangible results, bridging innovation gaps among regions. The EIT is home to innovations that make the difference for this planet, the EU and its citizens. New cancer therapies and other treatments prolonging human life; cleaning toxic waste for reuse; navigation belts for the blind; and truly innovative methods of generating energy and clean water. Not science fiction, but cutting-edge innovations from EIT innovators.

Europe's power to innovate is the lifeblood of Europe's economy. Investing effectively in innovation is therefore critical to Europe's future; we need to do much better at turning our research into new products and services to remain globally competitive. The EIT welcomes the European Commission's proposal for Horizon Europe, the 2021-2027 Framework Programme for Research and Innovation, as the right direction to achieve this.

By driving Europe's power to innovate and tackle its structural weaknesses, the EIT is making innovation happen by bringing together the key ingredients – business, education and research. This is managed through the development of dynamic European partnerships that include leading universities, research organisations and large companies, as well as start-ups and investors in our Innovation Communities.

The EIT is the only EU body to fully integrate the entire innovation value chain: from student to entrepreneur, from idea to product, from lab to the customer – including the scaling-up of successful start-ups.

We have set up six innovation communities around the following global challenges: climate change, digitalisation, health, renewable energy, food and raw materials. Two new communities in urban mobility and manufacturing will join the EIT Community in December this year.

Since the EIT was set up 10 years ago, it has created the largest innovation community in and across Europe – from north to south and, most importantly, from east to west – with 40 innovation hubs and more than 1,000 partners. We have created more than 6,000 jobs, 400 new products and services, created 300 start-ups and supported 800 ventures. EIT-supported start-ups have raised more than €600 million in external capital, with €150 million in 2016 alone, and they are just getting started.

The EIT Community knows what it takes to support innovators and entrepreneurs. Innovation needs a pipeline of ideas and talent; innovators are not only those with products for the market, but those with ideas at a much earlier stage. If only established innovators are supported, great ideas formed earlier in this pipeline are going to be missed. Europe cannot afford this. At the EIT, we begin by teaching entrepreneurs to start and run successful ventures, equipping them with robust entrepreneurial skills to thrive. Our education programmes work: more than 1,200 students have graduated from EIT entrepreneurial education programmes and we project 5,000 more by 2020, who will become job creators. In other words, empowering innovation is more than simply financing innovators, it is about giving them what they need to succeed;

Image: © The European Institute of Innovation & Technology (EIT)

Martin Kern, Interim Director at the European Institute of Innovation & Technology

bespoke support and access to Europe's largest innovation network.

By working with leading innovation stakeholders on the ground, the EIT is strengthening Europe's ability to innovate. With our 40 innovation hubs, strongly anchored in local innovation ecosystems, we bridge the existing gaps in innovation performance across Europe in a structured manner. Our EIT Regional Innovation Scheme for countries in Europe with more modest innovation capacity, works through local champions that cooperate closely with the EIT Community.

In Horizon Europe, the EIT wants to build on its strong base to continue to generate ground-breaking products and services, start revolutionary companies and train a generation of entrepreneurs. We want to form visionary leaders through unique entrepreneurial education programmes.

We also want to tackle new areas of Europe's key challenges and set up new Innovation Communities. Do you wonder where our water will come from? Do you think about the future of European culture and creative industries, security and migration? We do too and believe our model could make a difference. We also propose to roll out our model to new countries and regions, and to expand our entrepreneurial education model, because education is at the heart of innovation and our future.

Europe needs to scale what works and what delivers – that is very clear. This is how venture capitalists invest in successful businesses and the same principle should apply to how Europe invests in Horizon Europe.

As a body of the European Union, the EIT is Europe's most effective innovation powerhouse. It is Europe's largest innovation network. It will continue to focus on its unique ecosystem and bringing systemic change to European entrepreneurial culture. At the same time, the EIT delivers solutions to humanity's greatest challenges today. ■

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A fresh approach to research and innovation in Europe

The European Commission's fresh approach to promoting research and innovation in Europe is placed under the spotlight here by Open Access Government

On 15th May 2018, the European Commission outlined the steps needed to ensure Europe's global competitiveness, where research and innovation are concerned. In this important policy announcement, we learn that funding research and innovation is investing in the very future of Europe. This approach not only helps Europe to compete globally and preserve their unique social model, but it also enables them to improve the daily lives of millions of people in the region and all around the world, helping to solve some of the greatest societal and generational challenges.

In this vein, the Renewed European Agenda for Research and Innovation offers a set of firm actions to deepen Europe's innovation capability and to provide lasting prosperity in the region. Commenting on this vital area of policy, Carlos Moedas, Commissioner for Research, Science and Innovation, shares his thoughts about this.

"With growing international competition, Europe needs to act urgently on research and innovation. The proposed €100 billion for the next EU research and innovation programme would be a huge boost. But Europe also needs to reform the support for breakthrough innovation through a new European Innovation Council and reconnect with citizens through a mission-driven approach to research and innovation. We need to future-proof regulations and attract more private investment, in particular in venture capital."

Commission Vice-President Jyrki Katainen, responsible for Jobs, Growth, Investment and Competitiveness, added his own thoughts on the subject: "Europe has world-class research and a strong industrial base. But we must do better – much better – at turning that excellence into success. New megatrends, such as artificial intelligence and the circular economy, are going to bring profound changes to society and the economy. We need to act fast to be able to lead the new wave of innovation and set the standard for global competition."

The European Commission is determined that now is time to take their ambition to the next level, indeed where research and innovation are concerned they stress that they must act now to help Europe become a global innovation powerhouse, something that the region has the potential to be.

By way of background to this notable European Commission policy ambition, it is worth considering that with 7% of the world's population, Europe accounts for 20% of global research and development investment and produces one-third of all high-quality scientific publications. In addition, Europe holds a world-leading position in industrial sectors like chemicals, pharmaceuticals, mechanical engineering and fashion.

Europe is quite strong in sectors such as advanced manufacturing, aeronautics, pharmaceuticals, electronics, renewable energy and bio-based industries. Europe is said to have also taken strides forward in supporting innovation through key enabling technologies, such as biotechnology, photonics and robotics. Such technologies can be used and applied across many industries and are essential for addressing key challenges in society, we are told.

Having said this, we learn that Europe is lagging behind in many areas, indeed companies in the European Union are said to spend less on innovation than their competitors. Let's take a look at the figures in this vein – Europe spends 1.3% of GDP compared to 1.6% in China, 2% in the U.S., 2.6% in Japan and 3.3% in South Korea. Also, public investment across the European

Image: © European Union, 2018

Carlos Moedas, Commissioner for Research, Science and Innovation

Union falls short of the 3% GDP target and research and development intensity is still uneven among the regions of the EU, with investment and research efforts strongly concentrated in Western Europe.

> "With growing international competition, Europe needs to act urgently on research and innovation. The proposed €100 billion for the next EU research and innovation programme would be a huge boost. But Europe also needs to reform the support for breakthrough innovation through a new European Innovation Council and reconnect with citizens through a mission-driven approach to research and innovation. We need to future-proof regulations and attract more private investment, in particular in venture capital."

With the European Commission's renewed agenda for research and innovation, it's not all doom and gloom, however. Far from it if we look at the huge opportunities and new challenges offered by technology-driven innovation, digitisation and global megatrends like artificial intelligence (AI) and the circular economy, which offer huge opportunities but also create new challenges.

Competition globally is intensifying and could impact upon Europe's leading competitive position in key industrial sectors, but the European Commission believes that Europe must deepen its research and innovation capability to both improve and maintain the present European way of life. ■

http://europa.eu/rapid/press-release_IP-18-3736_en.htm

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Artificial intelligence (AI) makes learner-centred learning successful

Prof Dr Wolfram Hardt and Assistant Prof Dr Tudevdagva from Chemnitz University of Technology shares their expertise on how artificial intelligence (AI) makes learner-centred learning a success

Let us try to analyse the situation of the challenges faced by today's higher education institutions. Professors design their course while they aim to increase the capacity of knowledge. Every course has one or more pre-conditions to enter and an expected amount of previous knowledge or experience. Nevertheless, in reality, we do not know how the knowledge of the learner matches the course pre-conditions. Maybe the learner knows much more than we are expecting or maybe too less to meet the expected pre-conditions. If the learner already has some prior knowledge of the offered course topic, then they will be bored during a lecture. This will reduce the study interest and motivation of the learner and, therefore, the actual learning process.

Or the opposite could be true: the previous knowledge of a learner is not sufficient and as such, they will understand less from a lesson. This will also reduce the motivation of any learner. Both are challenging points for learning environments in adapting to the needs of the learner. This is what we call learner-centred learning. A learner's knowledge status and individual learning progress must be the optimisation normative for learning platforms, as well as teaching procedures.

Traditionally, basic solutions are already known. For example, some universities offer pre-courses for new students to prepare them for the academic start. Such courses are good for learners who do not match the pre-conditions. However, this solution is not applicable to all courses on offer and all individual learning statuses. Some universities offer online learning modules, but the learner has to find out independently that they need a supporting online module.

However, in any case, exams are offered for complete learner groups at the end of the teaching period. This process centred approach is easy to handle, but many resources in this vein are wasted. Students have to wait for the exam or they join exams without appropriate preparation, which of course, slows down the learning process.

To set up learner-centred learning, a learning platform as technology basis is needed. In addition, we collect the process data of each learning step individually. The learner's activity, progress, exercise results, as well as learning time, are important indicators of an individual's progress. All data has to be kept safe and anonymously to avoid any unwanted data usage, so we analyse the collected data by artificial intelligence (AI) methods. Deep learning-based strategies can be used to find and compare learning profile fingerprints. These fingerprints are used to establish motivation inputs for the learner and to adapt the learning modules as required. In this way, learner-centred learning programmes can be generated automatically. Self-assessment methods can be applied to this artificial intelligence (AI) based learning platform. Thus, the learner gets individual and detailed status information.

Once the learning progress matches the exam level, then the learner can join the exam. This decouples the learning processes, based on adaptive learning methods. This new approach to learner-centred learning offers high value for both learners and stakeholders, for example, at higher education institutions. In this respect, teaching quality can be raised, individual talents are supported and the learner's diversity, due to their educational background and personal experience, is managed successfully.

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Mathematics: A powerful tool for understanding the world

Dr Juan C. Meza, Division Director for the Division of Mathematical Sciences (DMS) at the National Science Foundation (NSF) reveals why mathematics is such a powerful tool for understanding the world around us

In the article, "The Unreasonable Effectiveness of Mathematics in the Natural Sciences", the well-known physicist Eugene Wigner once wrote about the wide applicability of mathematics even beyond its own field. So, why is it that mathematics has proven such a powerful tool for understanding the world around us?

For many people, mathematics research often seems esoteric, but the results inspire new ways of thinking and commonly lead to novel applications. Here at the National Science Foundation's (NSF) Division of Mathematical Sciences (DMS), we support research in mathematics and statistics, the research training of the next generation of mathematical scientists and a portfolio of national research institutes.

An unexpected outcome

One of the goals of DMS is to develop new mathematical theories, models and tools to help solve some of the most challenging problems in the physical, biological and life sciences. This research ultimately has a significant impact on the United States' health, security and economy.

A clear example emerged last year. In 2017, the U.S. Food and Drug Administration approved two new magnetic resonance imaging (MRI) devices that dramatically speed up scanning of the body – between eight and 16 times faster than conventional methods. Siemens' technology (CS Cardiac Cine) reveals movies of the beating heart and GE's technology (HyperSense) allows rapid 3-D imaging of the brain.

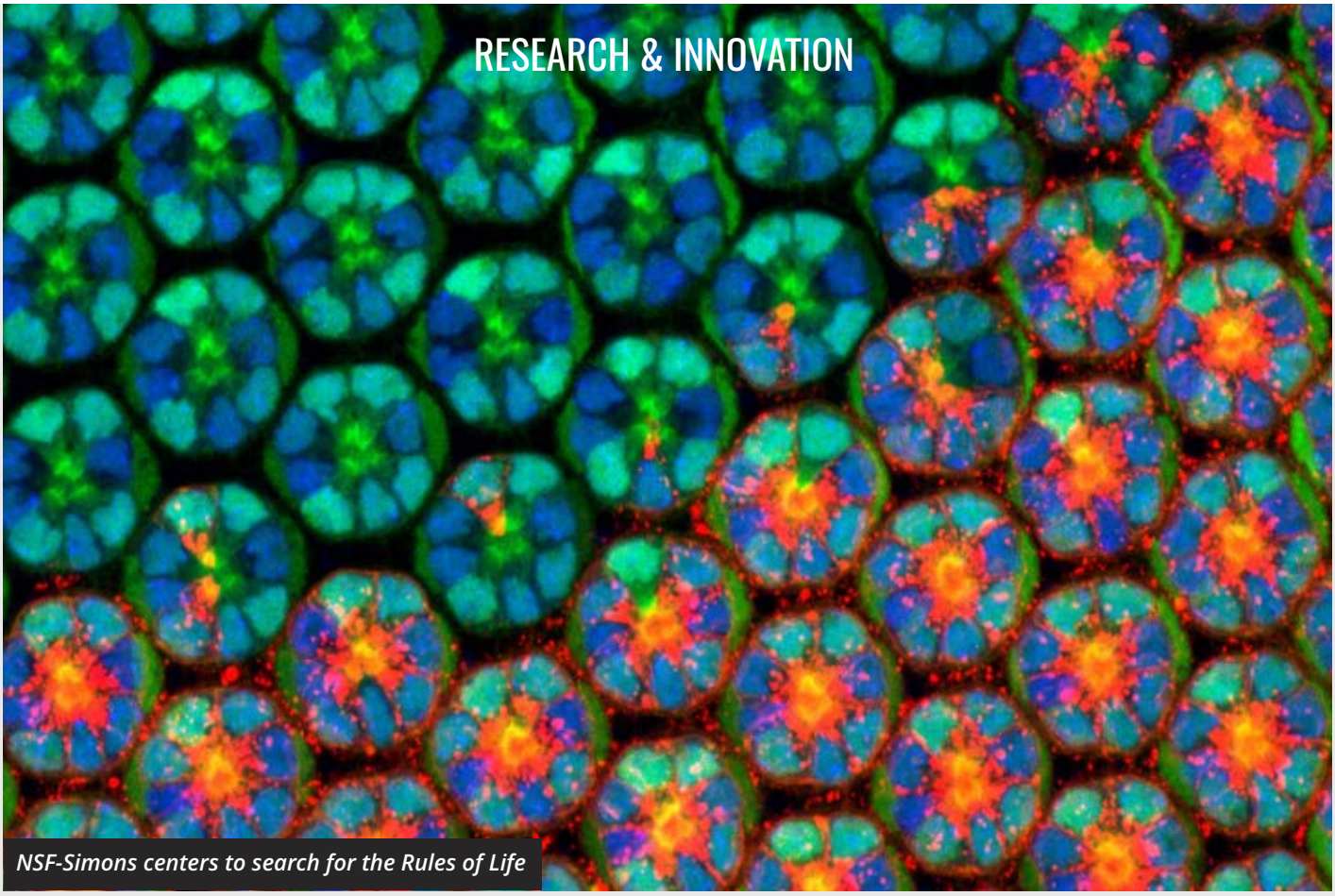
Both products make use of a mathematical technique known as compressed sensing, a breakthrough developed ten years earlier by NSF-supported mathematicians. While the underlying mathematics can be daunting, the idea is actually quite simple. The basis for this technique relies on the idea that many signals (audio, video, images) have a structure that we can take advantage of when they are first measured and then stored. By using mathematical algorithms, we can reconstruct images based on far fewer measurements than we had previously thought possible. One simple analogy is when we recognise a whole song by hearing just a few bars of the melody or recognise a picture from a few well-chosen features.

Using this technique, scanning is strikingly faster, resulting in patients spending much less time inside MRI machines. That's especially important for paediatric patients, where time inside an MRI must be restricted. The speed-up also allows for lower costs per patient.

The benefits are only now becoming widespread, but it was DMS-funded basic research that led to the new MRI technologies. Compressed sensing highlights the benefits of interdisciplinary research, as researchers from three different mathematical fields – geometric analysis, statistics and computational math – and from astronomy came together to work on this problem. It has been one of the great successes in the mathematical community, with a societal impact that is only just beginning.

Driving US mathematics research

DMS is the largest supporter of mathematical sciences research in the United States and accounts for more than 60% of federally funded basic mathematics research, including studies in algebra, topology and geometric analysis, number theory, applied mathematics, analysis, combinatorics, probability and statistics, computational mathematics and mathematical biology. We also support conferences and workshops and a portfolio of national mathematical sciences research institutes.



NSF-Simons centers to search for the Rules of Life

Image: © Northwestern University

DMS' six Mathematical Sciences Research Institutes run programmes for the research community and have a long history of bringing mathematicians together from around the world to share their work, which often leads to new collaborations.

Some of the activities supported by the institutes include programmes to discuss challenges in the development of materials for quantum computing, machine learning applications for computer vision and data-driven methods for precision medicine to guide treatment decisions – all of which have deep mathematical questions at their heart.

Bridging disciplines

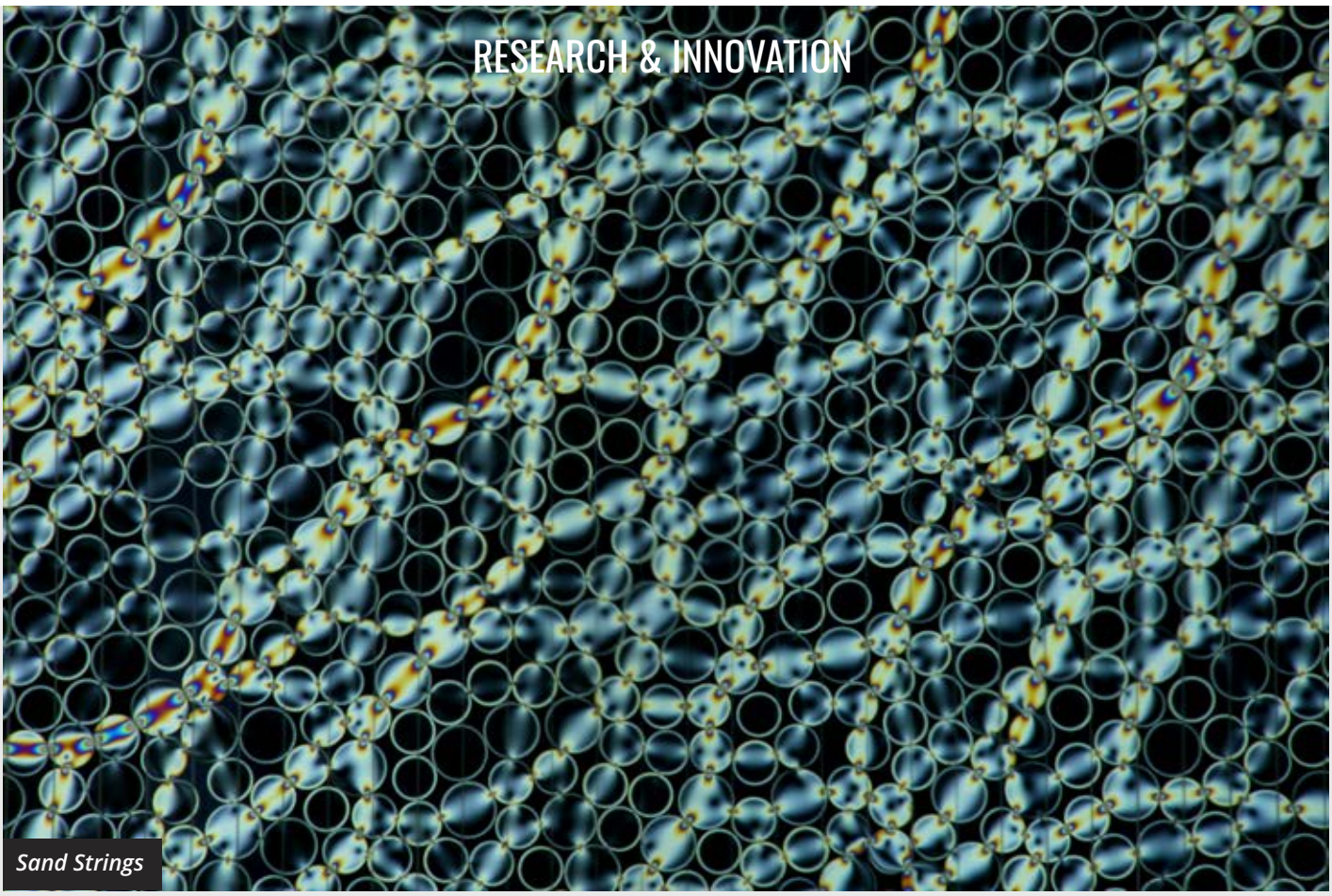
Another DMS guiding principle is collaboration with other science disciplines to develop new mathematics. For example, biology is now more quantitative than ever before because of new technologies like high-throughput, next-generation sequencers and high-resolution imaging and microscopy techniques. Such technologies have led to an abundance of new data for biologists to analyse, data that may answer fundamental biological questions, as well as raise new ones.

Building from that need is one of the most exciting activities emerging from DMS this year: a new partnership with the Simons Foundation – a private foundation that supports discovery-driven scientific research in mathematics and the basic sciences – to create four new Centers for Mathematics of Complex Biological Systems.

This $40 million programme is funded equally by NSF and the Simons Foundation and involves DMS and two other divisions in NSF's Biological Sciences Directorate: Integrative Organismal Systems and Molecular and Cellular Biosciences.

The centres will apply mathematical approaches in the hopes of developing predictive frameworks for understanding the pathways from DNA within cells to organisms interacting in nature. Such findings have potential for both pure scientific discovery and for a wide range of applications, from agriculture to health. One of the defining characteristics of the centers will be the close and sustained collaborations between biologists and mathematical scientists leveraging their complementary expertise and diverse perspectives.

DMS programmes span a wide range of energy and security applications, as well. Some mathematicians and statisticians are working on developing mathematical models for modelling efficient and reliable electrical power grid systems, while others work on mathematical algorithms for detecting threats such as outbreaks of epidemics like severe acute respiratory syndrome



Sand Strings

Image: © Jie Ren, Joshua Dijksman, Robert P. Behringer; Center for Nonlinear and Complex Systems, Duke University

(SARS). Yet others look for hidden patterns in large graphs (like the World Wide Web) that could indicate emerging threats. Mathematicians are even studying ways to help manage and mitigate the aftermath of natural disasters such as hurricanes.

The future of mathematics

In addition to basic research, DMS also places a strong emphasis on training the next generation of mathematicians and statisticians. Through research fellowships, we provide an opportunity for mathematical sciences doctoral students to participate in internships at national laboratories, in industry and at other approved facilities.

Our Mathematical Sciences Graduate Internship fellowship program is aimed at students who are interested in understanding the application of advanced mathematical and statistical techniques to real-world problems, regardless of whether the student plans to pursue an academic or non-academic career.

In 2017, we placed 40 graduate students from 38 universities in 10 national labs. All of the students were able to apply the theoretical coursework they had learned in school to real-world problems like improving computational meshes for simulations, deblurring images and machine learning.

Through the many such programmes and initiatives funded by DMS, new and exciting mathematics research is providing insights into some of the hardest challenges society is facing today, from understanding complex biology to deciphering the fundamental properties necessary to build quantum computers – and understanding their security implications.

While one cannot know where the next breakthrough in science or technology will emerge, mathematics will have been used to better understand or even predict it. Mathematics is essential to society and NSF's Division of Mathematical Sciences is positioned to support the needed mathematics that will help realise that new and better future. ■

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Physics: Optical microscopy in 3D

Dr Chunqiang Li, PhD from the Physics Department at University of Texas at El Paso explains the fascinating area of physics, optical microscopy in 3D

"Seeing is believing." Of course, we must validate what we see as a full picture. Living in a 3D world, dynamic information obtained from 3D space will provide much more enriched information than that from individual 2D snapshots. Two-photon excitation has the advantages of reduced photobleaching, photodamage and background signal suppression compared with one-photon excitation and has been widely used in biomedical research, particularly for *in vivo* imaging. Laser scanning two-photon fluorescence microscopes are the workhorse. These commercially available microscopes typically can acquire two dimensional (2D) images in the range of one to one hundred images/second by raster scanning the laser beam in a sequential manner. Typically, the laser beam scanning is the bottleneck of acquitting high-speed imaging.

In the last decade, several groups have demonstrated temporal focusing as a way of implementing two-photon microscopy for wide-field 2D imaging, without scanning the laser beam. In a temporal focusing two-photon microscope, the focal region is a light sheet with a diameter around a few hundred micrometres, depending on the focal length of lenses and femtosecond laser pulses. which only reach its shortest temporal profile at focal region. Therefore, when using a CCD camera as a 2D detector, this temporal focusing two-photon microscope can obtain wide-field 2D images without scanning laser beams. Based on the success of this technique, several groups have adopted temporal focusing to image cellular dynamics in thick tissues. Since it does not require scanning the laser beam, it could reach 1000 frames/second 2D imaging speed with an amplified femtosecond laser system as the light source.

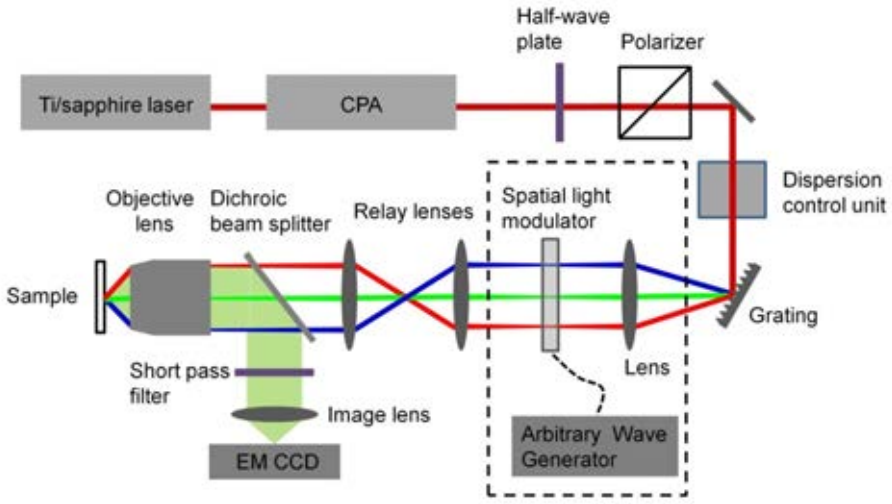

Fig. 1 Temporal focusing two-photon microscope with a pulse shaper setup.

In many applications, especially in live animal imaging, it is necessary to acquire information in all three dimensions. To achieve 3D volumetric imaging, most modalities still need to mechanically move the sample stage or the objective lens to acquire depth information (z-scanning). In the temporal focusing two-photon microscope, it has been demonstrated that changing the group velocity dispersion (GVD) of the femtosecond laser pulses could lead to the displacement of the plane of the temporal focus, along the optical axis of the objective lens, yielding z-scanning as a function of GVD. Femtosecond laser pulse shaping is a technique that spreads femtosecond laser pulse spectrum in space, then modulates each wavelength component with a spatial light modulator (SLM) to arbitrarily shape an ultrafast pulse. Hence, pulse shaping could electrically control the GVD of the femtosecond laser pulse without any mechanical motion, which could further control the z-scanning in the temporal focusing two-photon microscope. Therefore, the goal of our project is to integrate pulse shaping into temporal focusing two-photon microscopy to achieve 3D volumetric imaging without mechanical scanning.

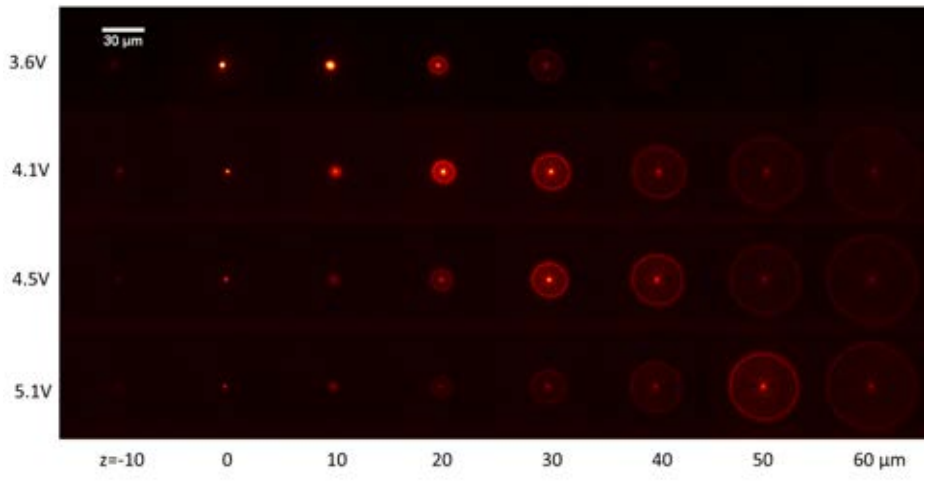

Fig. 2 Temporal focal plane shift by varying GVD. Series of fluorescent images of microspheres at different z positions (z= -10 to 80 μm) after the temporal focal plane is shifted at z=0, 20, 30, and 40 μm planes with varying GVD.

Figure 1 illustrates a schematic setup of the temporal focusing two-photon microscope. To achieve higher imaging speeds, a high peak power laser is needed. Therefore, a chirped-pulse amplifier (CPA) is added after the Ti:Sapphire laser to achieve high peak power (>1 uJ/pulse) at a repetition rate of more than 1 kHz. The incident angle of the grating is adjusted to ensure the central frequency follows the optical axis and propagates through the $4f$ setup, which comprises the collimating lens, relay lenses and the objective lens. Since the spectrum of femtosecond laser pulses has been spread out spatially by the grating, the next step is to add a pulse shaper (dash box in Figure 1) to use acoustic waves to control the dispersion of the femtosecond laser pulses in the spectral domain to achieve scan-less 3D volumetric imaging. The spatial light modulator (an acousto-opto modulator, AOM) is located at the $1f$ location to the left of the first collimating lens. The AOM is driven by a radio frequency arbitrary wave generator to create the desired radio frequency wave that controls the GVD of the femtosecond laser pulse.

Our microscope demonstrated the capability of shifting the temporal focal plane via pulse shaping. We applied different voltages on the arbitrary function generator and the z position of the sample was scanned by moving the 3D sample stage with x and y positions fixed and finally, a fluorescence image was acquired at each z position. This varying voltage function induced GVD on the laser spectrum and changed the temporal focal plane, as shown in Figure 2. This shifting of the temporal focal plane by applied GVD depends on several parameters, such as laser spectral width and the numerical aperture of the objective lens. The temporal focal plane was shifted to z= 60 μm plane by applying a voltage of 10.2 V. This separation of the temporal focal plane from the geometric focal plane has a negative effect on the image quality. When the temporal focal plane is slightly shifted away from a geometric focal plane in the range of ±10 μm, the single fluorophore image becomes blurry. When this shift is larger, the single fluorophore image has the characteristics of concentric rings with peak intensity in the outermost ring and the central lobe becomes blurred as shown in the second to fourth row in Fig. 2.

Overall, we integrated ultrafast laser pulse shaping with the temporal focusing two-photon microscopy and achieved a high-speed 3D imaging method. This 3D imaging system requires neither laser beam steering nor sample mechanical scanning. The depth scanning is achieved by controlling the femtosecond laser spectrum. The dependence of scanning depth on the applied electronic signals which can be tuned at a millisecond timescale. Its high-speed 3D imaging capability was demonstrated by imaging fluorescence microspheres in a volume of 100×100×80 μm^3.

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The advancement of physics in Europe

The history and work of the learned European Physical Society (EPS) are given special focus here by the Editor of Open Access Government, Jonathan Miles

The European Physical Society (EPS) is a learned society, committed to engaging in activities that strengthen the ties between the physicists of Europe. The members of the EPS comprise 42 National Physical Societies in Europe, plus respected individuals from all fields of physics and a number of European research institutions. The EPS is very much concerned with issues that affect all European countries around the areas of physics research, science policy and education.

By way of background, the EPS began its life in 1968, thanks to the inspired leadership of Gilberto Bernardini (1906-1995). At his inaugural address, he shared his thoughts on the formation of the EPS, referring to collaboration in human life and the role of the EPS in contributing to the advancement of physics in Europe.

Bernardini said that: "the formation of the European Physical Society with such a wide membership is a further demonstration of the determination of scientists to collaborate as closely as possible in order to make their positive contribution to the strength of European cultural unity."

"Nowadays, collaboration is a magic word. It is applied in almost all aspects of human life from economy to religion. But it is often quite hard to convert the ideal of collaboration into something really effective, rather than a utopia.

"It may be that we who joined the European Physical Society this morning are utopians. But I am inclined to believe that the society is based on practical and objective grounds and that it will become capable of contributing significantly to European physics."

Representing the physics community

Since the creation of the EPS, the European Economic Community has progressed into what we know today as the European Union (EU), which currently has 28-member states. The increasing importance of the EU has given the EPS a role in representing the physics community at the level of the European Commission and the European Parliament. As a not-for-profit organisation, the EPS is dedicated to promoting physics in research, education, student mobility, publications and outreach.

> "The EPS vehemently argues that long-term investments in research funding and scientific infrastructure are critical for Europe's cultural, economic, social and cultural development. As such, the EPS has opened an office in Brussels with a dedicated consultant for EU affairs."

In terms of the mission of the EPS, it could not be clearer. On their website, we find out that their aim is to contribute to and promote the advancement of physics in Europe and in the neighbouring countries. They then explain how this can be achieved, in their own words, for example by "all suitable means and in particular by providing a forum for the discussion of subjects of common interest and by providing means whereby action can be taken on those matters which appear desirable to handle on the international level."

Science and research policy

The EPS vehemently argues that long-term investments in research funding and scientific infrastructure are critical for Europe's cultural, economic, social and cultural development. As such, the EPS has opened an office in Brussels with a dedicated consultant for EU affairs.

Also, the EPS has created create an Advisory Board on Science Policies (ABSP), the members of which can provide scientific advice on a number of policy issues. The aim here is to build a dialogue between the EPS and EU policymakers and to interact with the members of the High-Level Group of Scientists of the EC's Scientific Advice Mechanism (SAM).

Closing remarks

Looking through the many worthy activities of the EPS over the years, in this article and on their website, there is no doubt that they are living up to their founder's objective – to contribute "significantly to European physics." ■

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Physics: Inside quantum matter and beyond

Román Orús from Institute of Physics, Johannes Gutenberg University takes us on a journey through the complexity of quantum systems

In physics, the field of quantum information and computation has become a mature discipline. Starting from the pioneering ideas of physicist Richard Feynman on quantum simulators, recent developments motivated the study of what Albert Einstein called "spooky action at a distance", commonly known nowadays as *quantum entanglement*. This "entanglement" is *the key property* behind many of the most outstanding and counterintuitive properties of quantum mechanics and its study has propelled new research directions recently.

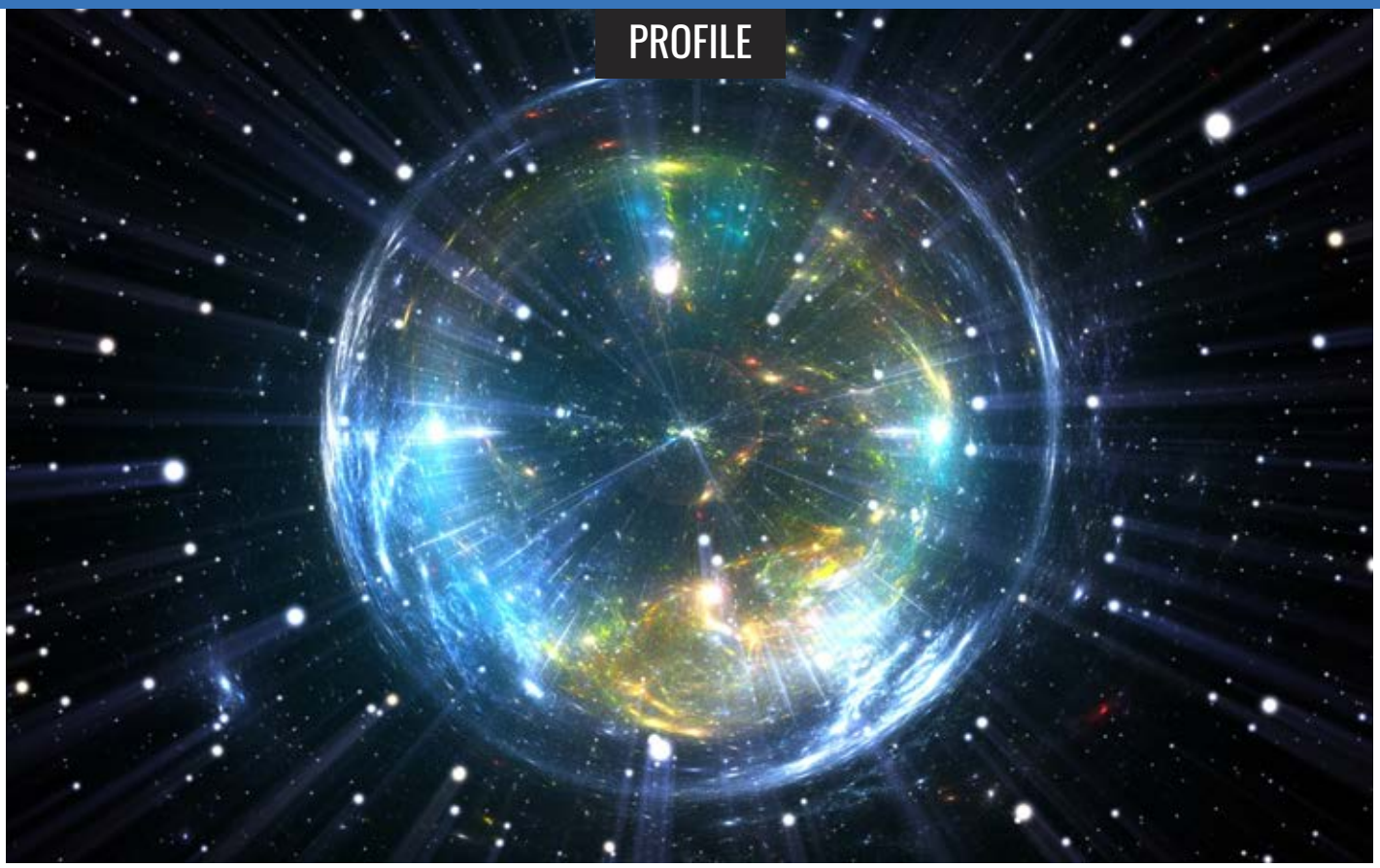
One of those directions is the study of entanglement in quantum matter, that is in aggregates of many quantum particles or, to say it differently, in *complex quantum systems*. The properties of such systems, built up by many (perhaps infinitely-many) individual constituents, have been to a great extent obscured due to the complicated equations governing their behaviour. And this is a pity, because it hinders progress along many directions: from the design of new materials and drugs, to the development of new algorithms for artificial intelligence (AI)... and even to the understanding of the fundamental nature of space-time.

A game-changing discovery, though, has been that quantum matter has an inherent mathematical structure when it comes to understanding its quantum properties. And this structure can be described, formally, by what researchers call "tensor networks". These are networks of entanglement where mathematical objects, called tensors, describe locally the properties of the aggregate[1].

Tensor networks are new tools to understand old problems. They have propelled the understanding of many aspects of quantum matter that remained obscure to scientists over decades. A prominent example is that of topological properties of materials. Such properties cannot be described by the classical paradigm of phase transitions, what physicists call "Landau theory". Instead, non-local quantum effects are the key towards their understanding. And this is no joke: systems with topological properties hold the key to the design of topological quantum memories, as well as to topological quantum computation, which are disruptive technologies nowadays pursued by several laboratories worldwide and with the potential to change many aspects of our society. In this respect, tensor networks have allowed a precise mathematical understanding of all the intricate properties of topological matter. In particular, models such as the so-called "Kitaev's Toric Code"[2] (the simplest and most paradigmatic topological model) can be fully understood in the tensor network language, in turn, allowing to perform numerical simulations predicting their behaviour under external perturbations with the aid of powerful algorithms[3].

But the achievements of tensor networks in the field of quantum matter go much further than topological systems. A good example is the numerical simulation of two-dimensional quantum lattice systems. On the one hand, today we can predict, with unprecedented accuracy, phase diagrams of complicated two-dimensional models that remained elusive for many years. For instance, the so-called "infinite-PEPS algorithm"[4] (a specific tensor network numerical method) has allowed us to obtain the best energies for the Hubbard model in the strong coupling regime[5]. This model is believed to be the key to understand high-temperature superconductors and its most accurate predictions are currently obtained via tensor networks.

In connection to this, the same algorithm has been used to predict the properties of some magnetic materials of paramount importance, such as the so-called Kagome Heisenberg antiferromagnet. The properties of such system remained elusive for many years until recent numerical simulations with tensor networks determined, once and for all, its ground-state properties[6]. On the other hand, a new tensor network method has been recently proposed to simulate the effect of dissipation in two-dimensional quantum systems[7].



This new method opens an entirely new field of research that is full of exciting possibilities.

Nevertheless, the most intriguing fact about tensor networks is that they are also at the core of other important problems where nobody expected them to show up. There are three clear examples of this: quantum gravity, machine learning and theoretical linguistics. In quantum gravity, it has been found that the quantum structure of space-time is actually a tensor network, favouring the intuition that our universe seems to be nothing but a complicated network of entanglement[8]. This stimulating idea is one of the strongest hints towards the unification of quantum mechanics and general relativity, probably the most important open problem in physics. As for machine learning, it has been recently understood that deep learning structures, such as convolutional and recursive neural networks are, in fact, particular cases of tensor networks[9]. This implies that the mathematical machinery of quantum information can also be applied, in its full glory, to computer science, thus helping to develop better algorithms for AI, such as those found in self-driving cars and face-recognition systems. And finally, when it comes to linguistics, researchers have understood that the syntactic structure of human language also corresponds to specific examples of tensor networks, hinting directly at the way in which our brain processes information, as well as to universal properties of language[10].

The history of tensor networks exemplifies how developments in one field trigger, in the long run, unprecedented applications in others. There is an important lesson that we must learn from this: what is sometimes regarded as useless, irrelevant science in the short term, may actually turn out to be *the key ingredient in the long term*. This is a lesson that our governments and administrations should never forget. Investment in science must not depend on a short-term perspective only, because good science is like a good wine: it just gets better with time.

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Friction & sound: A partnership for better or for worse

Julien Scheibert & Alain Le Bot, researchers at CNRS/Ecole Centrale de Lyon explore the fascinating area of friction & sound, revealing why this is a partnership for better or for worse

Friction sound, that is sound due to the rubbing of solids, are part of our daily lives. They shape our perception of the environment, for better or for worse. Of course, the sounds made with musical instruments, such as a violin delight our ears (figure 1). But many others such as the squeak of doors, or the squeal of brakes are aggressive or can even scare us, as evidenced in the squeal of tyres during emergency braking. We estimate that the rolling noise emitted by cars is the first cause of noise pollution in the urban environment. Noise annoyance in our cities has become a recognised public health issue, the treatment of which remains a true social challenge, with considerable medical costs for our society.

Figure 1

> "Increasing our knowledge of dynamical effects in friction, like sound, is actually central in the scientific strategy that we implement in our lab."

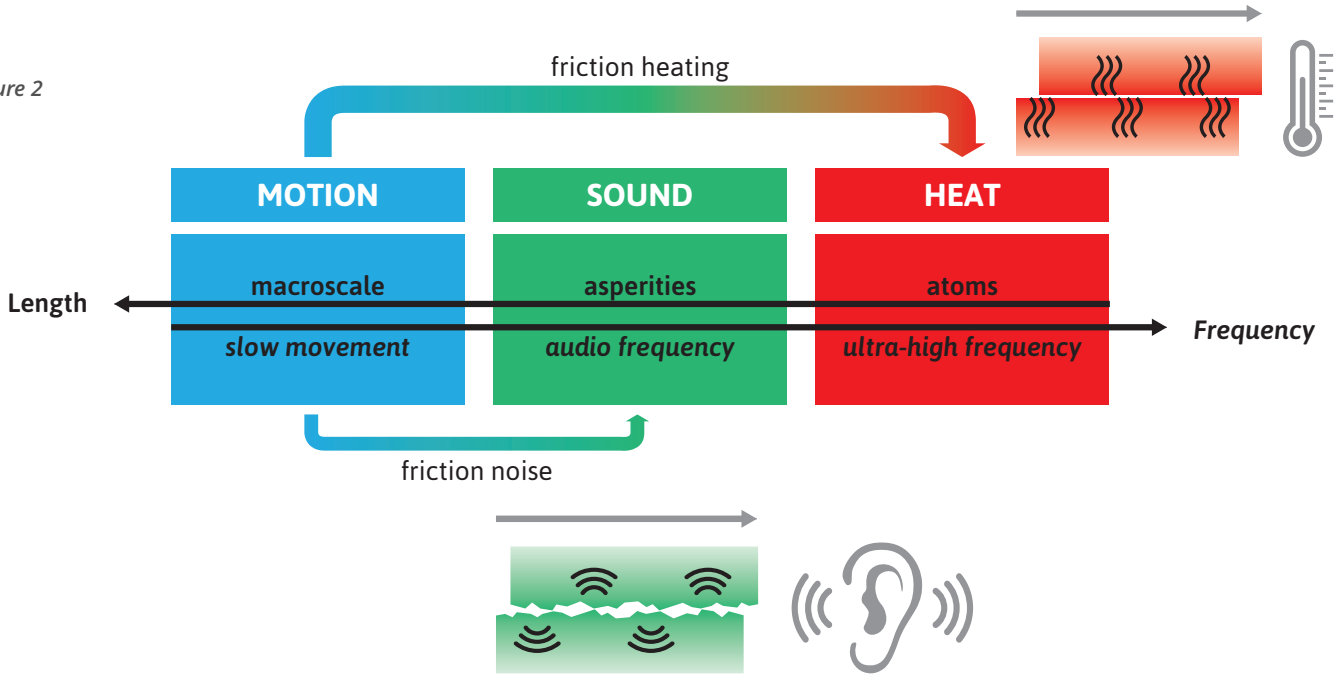
The industrial challenges are no less important. How does one design a noiseless road? How do we avoid the squealing of brakes or belts? What can we learn about the health of our devices by scrutinising the sound they emit? Is it possible to design our environment to increase our acoustic comfort? More generally, the question is how to control the friction sound of our everyday life equipment to make our lives more pleasant and safe?

All these questions demonstrate the necessity to increase our scientific understanding of friction sounds. One thing is already certain: tribologists (the scientists studying friction) and acousticians (the scientists studying sound) will be partners in this battle to save our ears.

Indeed, if there is noise, there is some rubbing somewhere! And the noisier something is, the stronger the underlying friction. Haven't you ever thought that your windows would be cleaner if the rag would make a substantial noise? Don't you feel that your hair is cleaner when shampoo makes a stronger squeal noise? But the relationship between friction and its noisy consequence could turn out to be subtler than it appears at first sight.

So, what can tribology teach us about the physical processes that cause friction sounds? To answer this question, one must dig into the small scales of the contact surface itself. Surfaces are never perfectly smooth, but as soon as we zoom in, we discover complex landscapes made of asperities with random shapes and heights. As a consequence, a sliding contact, which might appear as homogeneous at a large scale, actually consists of discrete collisions between asperities, at random locations and instants. All those rapid collisions act as tiny hammer strokes, which excite the vibration of the whole rubbing body, finally inducing the sound that reaches our ears[1]. From this scenario emerges a dynamic picture of friction, with a key role of short time scale effects, which remain poorly understood in tribology. Increasing our knowledge of dynamical effects in friction, like sound, is actually central

Figure 2



in the scientific strategy that we implement in our lab.

> "Noise annoyance in our cities has become a recognised public health issue, the treatment of which remains a true social challenge, with considerable medical costs for our society."

More tribology helps us to understand sound. This is okay, but the opposite question is one worth raising: to what extent can acoustics help us to understand the elementary mechanisms of friction? Friction is an energy dissipating force whose physical origin remains elusive. Even today, after centuries of research, friction is still an important scientific challenge in modern physics. Like all dissipation mechanisms, friction must be considered as a thermodynamic process which transforms a "noble" form of energy – macroscopic motion – into a "degraded" form of energy – heat. It is well established that heat is a vibrational energy at the scale of atoms. What about the friction sound? As discussed above, it is also a transformation of energy from a macroscopic motion into a vibration but operating at the scale of contact asperities[2]. A simple idea thus emerges: the difference between sound and heat may just be a question of scale[3] (figure 2). Both are vibrations, but heat simply involves smaller length and time scales, making it impossible to be detected by our ears.

Can we use this analogy to suggest useful hints about how friction research should be organised? The community does agree on the central role of the so-called "energy budget". This term simply means that if we could quantify the energy dissipated in all the possible forms, mainly heat and vibrations, we would understand friction. The direct implication is that friction studies should, as much as possible, involve close collaborations between tribologists and acousticians. Tribology labs should open their doors to more vibration scientists, a strategy that we have been pursuing for several decades in our own institution. Similarly, seismologists (the acousticians of Earth) would benefit from an alliance with tribologists to elucidate the triggering mechanisms of earthquakes, the friction noise of the Earth's crust. The fruitful partnership between tribologists and acousticians, therefore, has a bright future.

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The priorities for education and research in Italy

Open Access Government takes a look at the priorities for education and research in Italy, including the recent appointment of a new Minister of Education, University and Research in the country

In Italy, the overriding aim of higher education is to promote the scientific progress of the country and to ensure that all citizens can take part in education and training that will lead to employment.

When it comes to higher education in Italy, the key principles are detailed in the Italian Constitution, adopted in 1947. Article 33 of the constitution states that: "art and science are free and the teaching thereof shall be free". Defending academic freedom, the article also explains that all higher education institutions: "have the right to establish their own regulations autonomously, within the limits set by national legislation".

In addition, Article 34 of the constitution emphasises the right of all individual citizens to enter higher education: "All those who can prove the necessary competency and commitment have a right to pursue the highest levels of education, regardless of their financial means."

By way of background, back in 2001, the former Ministry for Universities and Scientific and Technological Research (MURST) merged with the Ministry for Education (MPI) to form the new Ministry of Education, Universities and Research (MIUR) that is known today.

In short, MIUR essentially promotes research on a scientific and technological level, plus the development of universities and other higher institutions endowed with university status. MIUR coordinates developments and changes in the university system and it funds individual universities and co-ordinates Italian participation in EU and international programmes concerning higher education and research.[1]

Since June 2018, the post of Minister of Education, University and Research in Italy has been held by Marco Bussetti, who was born in May 1962.[2] He forms part of the Conte Cabinet, led by Prime Minister Giuseppe Conte, who was sworn in as Italy's new Prime Minister in June this year.[3]

In terms of Marco Bussetti's background, this is certainly something worth exploring further. Born in Varese in 1962, he later graduated in at the Catholic University of the Sacred Heart in Milan. Following that, his professional career became closely linked to the world of education and training.

From 2014 onwards, he was a manager of the Regional School Office for Lombardy in the Territorial Area of Milan and Metropolitan City, having previously worked as the managing director of the Territorial Area of Monza.

Bussetti has held teaching positions at a number of universities, such as the Catholic University of the Sacred Heart in Milan, the University of Milan and the University of Pavia. He also worked with the General Directorate for Student, Integration and Participation of MIUR, as a member of several working groups.

In 2010, took part in the Ministerial Commission that was responsible for the elaboration of National Guidelines where high school students are concerned. He is also the author of a number of publications on topics related to the school world.[4]

Only on 1st June this year, he replaced Valeria Fedeli who held the position of Minister of Education, University and Research in Italy between December 2016 and June 2018.[5] Following the recent change in Italy's government, it's worth looking at some of Valeria Fedeli thoughts, which she conveyed to her successor, Marco Bussetti. These include a number of urgent priorities, including protecting staff and students in all institutions of education in Italy.

"To hold an institutional position means to take care of the country, with regard to the sector of its competence, in the sole interest of citizens and citizens and with a deep and rooted sense of responsibility. That's why I decided to leave the new Minister, to whom I wish my best wishes, a document containing measures and measures adopted and detailed information on the most urgent issues to be addressed in the coming months to protect female students, students and all women and men who work daily in our schools, universities and research institutions supervised by MIUR."

Valeria Fedeli advised on vital matters for her successor to attend to, including the following:

- Measures to ensure the continuity of teaching for non-role support teachers and;

- The required operations to ensure an orderly start of the new school year, with all the professors from day one.

The former Minister, Valeria Fedeli, also adds that a firm commitment and a quick intervention by the next Minister are required on this and other matters. Let's leave the last word to Valeria Fedeli, who offers her views on the priorities for graduates at the commencement of the next academic year.

"Following the decision of the Council of State in the Plenary Assembly of last December, on the issue of graduate students, it will be necessary to find a legislative solution that respects their rights, as well as those of graduates in primary education sciences, and that to guarantee an orderly start of the next school year, in the interest of female students and students."[6] ■

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The synergistic use of atmospheric data from space: from research to operational products

Ugo Cortesi (IFAC-CNR), on behalf of the AURORA Consortium, explains the synergistic use of atmospheric data from space

The launch of the Sentinel-5 precursor satellite on October 13th 2017 heralded a new phase of operational monitoring of atmospheric composition from space, which is going to reach its full deployment with the acquisition of first real data by Sentinel-4 and Sentinel-5, the atmospheric missions of the ESA/EU Copernicus programme, envisaged to take place by 2023.

An unprecedented quantity and quality of satellite and non-satellite measurements of key gaseous compounds and particulate matter in the Earth's atmosphere will become available, making it possible to develop applications and services, ultimately to address the increasingly complex challenge of protecting the environment and security using data from space.

A demanding project, funded by the Horizon 2020 framework programme of the European Union, began in 2016 to explore the potential of the information content concerning the new number of observations that were made possible by exploiting the synergy of data from space and the synergy of tools.

The AURORA (Advanced Ultraviolet Radiation and Ozone Retrieval for Applications) project is conducted by a consortium, led by CNR-IFAC (Italy) and includes the major scientific institutions in the field of atmospheric sciences in Europe, such as BIRA-IASB (Belgium), ECMWF (United Kingdom), FMI (Finland), KNMI (Netherlands) and outstanding SMEs like Flyby (Italy), Epsilon International (Greece), 52Impact (Netherlands) and S&T (Netherlands).

The novel idea at the core of the AURORA project is, in fact, to test the application of state-of-the-art assimilation models on the results of innovative data fusion techniques, capable of combining the information from measurements of the same air mass simultaneously acquired by ultraviolet, visible and thermal infrared instruments onboard geostationary and low earth orbit platforms, such as Sentinel-4 and Sentinel-5, respectively.

Rather than looking at data fusion methods and data assimilation systems such as alternative tools for combining redundant and/or complementary information on the state of a given variable from multiple measurement sources, AURORA investigates – for the first time to our knowledge – the sequential application of data fusion and data assimilation to atmospheric remote-sensing observations.

The atmospheric target selected for testing of the AURORA concept is the vertical profile of ozone from the Earth's surface to the top of the atmosphere. The choice of ozone was motivated both for the key roles it plays at different altitudes in the atmosphere as a major absorber of ultraviolet radiation and as climate forcer and pollutant, as well as for the significant benefit expected from synergistic use of its observations in different wavelength ranges.

Intermediate and preliminary results obtained on synthetic data of the atmospheric Sentinels demonstrated the advanced quality of fused products, with respect to standard retrieved profiles and first outcome of assimilation of these fused data highlighted non-negligible differences between the assimilation of fused and standard products.

It is worth mentioning that, along with other experiments running the assimilation of data from the atmospheric Sentinel missions, a specific test will be devoted to estimate the impact of assimilating standard ozone profiles retrieved by the TEMPO (Tropospheric Emissions: Monitoring Pollution) and GEMS (Geostationary Environmental Monitoring Spectrometer) geostationary missions, whose coverage of North

America and Asia-Pacific region, respectively, is complementary to that of Sentinel-4 over Europe, thus providing the first constellation of operational geostationary satellites for air quality monitoring in the Northern hemisphere.

Completion of the planned set of assimilation experiments on the selected dataset of simulated observations (four months) aims to consolidate and validate the output of the AURORA data processing chain, with the twofold purpose of contributing on the one hand to the efforts for upgrading synergistic data from research to operational products, and to the other of developing a technological infrastructure which is capable to run the data processing chain of AURORA using synthetic measurements now and real data from space as soon as they are distributed.

Although the transition from simulated to real data processing is far from being a straightforward step and necessitates a substantial volume of additional workload, the on-going activities deliberately included among their objectives, the delivery of a few applications based on the use of AURORA Ozone profiles and derived products, such as the tropospheric ozone columns at the lowermost levels of the atmosphere and the ultraviolet radiation reaching the surface, for demonstration purposes. Two applications, in particular, will be tested on the AURORA products, both of which are of interest to the health sector. The first one, HappySun, is a personal UV dosimetry already available on smartphones and operates on the basis of information obtained from spaceborne sensors. The second one, AirPortal, aims to monitor and forecast air quality in urban areas at the resolution of 100m x 100m, by combining data from space and ground stations with information on land usage and meteorology. Other sectors are also under consideration for development of further applications with the underlying intent to exploit the potential added value of the AURORA advanced quality data.

As part of the initiatives for communication and dissemination, constantly updated in the news section of the project website and mirrored in synthesis in the AURORA list of publications, it is important to highlight the contribution to the New Scientist Live event 2018 (London, UK), as well as the publication of a Call for Ideas for university and high school students in the member states of the European Union.

More details and material about the various aspects of the project can be found on the AURORA official website.

A video displaying a general introduction to the objectives and scope of AURORA activities is also accessible here, which includes interviews with representatives of key actors in the AURORA project.

AURORA web-site:
http://www.aurora-copernicus.eu/

AURORA video:
http://www.aurora-copernicus.eu/video

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Timber frame construction: An evidence-led choice that is growing rapidly in popularity

Gareth Barber, Managing Director of the Stable Company presents the case for timber frame construction, exploring this truly exciting and high-tech material – and why further research is crucial

Recent research has unearthed new building techniques that could even make timber suitable for high rise developments. Other studies have also highlighted timber's physiological benefits to humans – this article explores this truly exciting and, surprisingly-to-some, high-tech construction material – and why further research is crucial.

Why choose timber frame construction?

Timber frame construction is the ultimate environmentally-conscious choice. As a 100% renewable building material, timber distinguishes itself from traditional rivals, brick and concrete, whilst also demanding far less energy to manufacture. In addition, timber stores greenhouse gas from the atmosphere. A report by Wood for Good estimated that if all house-building targets in the UK were met with timber frame construction, the UK could become a carbon bank – storing 3.8 million tonnes of CO_2 every year.

Financial considerations also make timber frame a popular choice. For many projects – particularly those in the public sector, where budgets are usually tight, such as in the UK – cost is a crucial consideration. These 'green' credentials potentially open timber frame construction projects up to funding, grants or other financial support from local authorities. This is not to mention that timber is usually a lower-cost option when compared to brick and concrete, regardless of any extra financial support.

The cost-effectiveness and speed of timber frame construction make it easier and more feasible from a budgetary perspective to factor in other features such as, for example, floor-to-ceiling windows – which maximise natural light (and thereby minimise financial and environmental expenditure on artificial lighting). Modular buildings are simpler, more practical and cost-effective to adapt as needs evolve than buildings constructed by traditional methods.

Interestingly, a study – Behavior Changes in Older Persons Caused by Using Wood Products – noted increased talkativeness between subjects when in the presence of wood. Other studies have elucidated timber's physiological benefits to humans; the presence of wood has been shown to reduce blood pressure and induce feelings of calmness. This makes timber frame construction an evidence-led choice for schools, hospitals, rehabilitative institutions or elderly residential centres.

How does timber perform, however? What about its thermal properties?

Timber is hygroscopic – improving indoor air quality by moderating humidity – making it a very popular material for buildings with sensitive contents, such as garages – or simply for keeping its occupants comfortable. Breathable and naturally-insulating, timber maintains a more stable temperature than concrete or brick and is able to be fully draught-proofed.

Timber's cellular structure contains air pockets which limit the material's ability to conduct heat. Modern timber frame buildings are also capable of being fitted out with artificial insulation, supplementing these natural properties and already-low thermal heat transfer levels. This high-tech insulation is contained within the structure in the timber cavity, meaning that the walls of a timber frame building can be much thinner than concrete or stone, whilst achieving the same level of insulation – also saving on vital building space. The minimum insulation specification is 150 mm glass wool.

Natural properties, combined with the use of innovative artificial insulation, mean that timber frame buildings

are cooler in the summer and warmer in the winter. This saves on heating and cooling, thereby nonrenewable energy use – a financial and environmental plus point.

The importance of timber research

Tight budgets limit the size and scope of building projects, but can also curb creativity or experimentation. As an inherently more affordable approach, timber frame construction projects give more opportunity to experiment with the wealth of exciting techniques and aesthetic outcomes that exist. By allowing for enterprise with styles, it's possible to discover ways to further improve the user-friendliness and aesthetics – two hugely important factors in good building design.

Recent timber research has focused on the development and uses of Cross-Laminated Timber (CLT) – an innovative new technique that combines several layers of timber, creating an extremely strong and load-bearing compound. Research and experimentation with CLT – which is as strong as steel – unlocks a whole new range of design possibilities; these have even included plans for a 10-storey timber frame building. Certainly, a twist on the idea of a 'concrete jungle'.

With environmental sustainability high on the agenda of governments, councils and businesses the world over, CLT is attracting growing attention, placing importance on further research into this building method. Concrete development accounts for 5% of all carbon emissions; research by Yale University suggests that a global switch to timber would cut the construction industry's carbon emissions by 31%.

Research into construction methods like CLT means that wood is back with a vengeance, to the benefit of the environment – as well as our pockets. ■

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Austria as an international destination for research and collaboration

The Federal Minister of Education, Science & Research promotes Austria as an international destination for research and collaboration, as well as promoting science at the grassroots, as this analysis from Open Access Government reveals

Austria's Federal Ministry of Education, Science & Research (BMBWF) works to accelerate research, technology and innovation while representing the country's interests as a scientific, research and business location on the international stage.

The ministry is responsible for the entire school system, including both general education and vocational training, as well as teacher training colleges and European and international cooperation around education. It also oversees adult education and lifelong learning, educational research, school maintenance and teacher materials and media training.

For a small country like Austria, knowledge capital is crucial and universities, technical colleges and research institutions bring international knowledge to their location. They also train highly qualified professionals for business and society and are magnets for innovation and creativity.

Austria currently has 22 universities, 21 universities of applied sciences and 13 private universities.

The BMBWF supports the country's scientific institutions in developing their profile and channels public investment into scientific research.

International cooperation and competition are seen as particular strengths of Austria's scientific institutions and the ministry works to actively position them as attractive partners for private sector firms and research institutes.

At the same time, Austria is also participating in the establishment of a European Research Area (ERA), which aims to create a framework to address the key challenges of the coming decades in a sustainable manner.

The ERA will essentially create an "internal market" for research, where researchers, knowledge and technology can circulate freely.

> "Since January, Dr Heinz Fassman has been the federal minister for education, science and research. Dr Fassman has an extensive background in science and research, receiving a doctorate from the University of Vienna before working as a researcher at the Austrian Academy of Sciences and, since 2000, as professor of applied geography, spatial research and regional planning at the University of Vienna."

It will also encourage European-level coordination of national and regional research activities, programmes and policies, as well as initiatives implemented and funded at European level.

The BMBWF is responsible for coordinating Austria's involvement in the EU's Horizon 2020 framework programme. Running from 2014 to 2020 and with a budget of around €80 million, Horizon 2020 is the world's largest transnational research programme and a key tool in realising the ERA.

To support the internationalisation of Austria's higher education and research institutions and to promote them on the global stage, the ministry has participated in numerous bilateral and Europe-wide initiatives.

International treatments and agreements are among the most important instruments in promoting cross-border

cooperation, with Austria's neighbouring countries and the nations in Eastern and South Eastern Europe seen as regional priorities.

In addition, the ministry represents Austria's interests in international bodies, such as the Strategic Forum for International Science & Technology Cooperation of the European Union, the Committee for Scientific & Technology Policy of the Organisation for Economic Cooperation & Development, as well as relevant bodies of the United Nations.

To inspire the next generation, the BMBWF funds the Sparkling Science programme. Launched in 2007, Sparkling Science uses unconventional ways to promote young scientists that is unique in Europe.

Since it launched, around 300 projects have been launched with scientists working side by side with young people on current research questions in a method known as "Citizen Science". Research topics cover a wide spectrum, from mechatronics and molecular biology to migration research, acoustics and biometrics.

In the 2016 call for applications (for projects starting in July 2017), a total of 39 projects were awarded €6.5 million.

Since January, Dr Heinz Fassman has been the federal minister for education, science and research. Dr Fassman has an extensive background in science and research, receiving a doctorate from the University of Vienna before working as a researcher at the Austrian Academy of Sciences and, since 2000, as professor of applied geography, spatial research and regional planning at the University of Vienna.

He became director of the Institute for Urban & Regional Research in 2006, a real member of the Austrian Academy of Sciences in 2007 and has been a member of the Council of Experts of German Foundations for Integration & Migration since 2009.

Functions and memberships of Dr Heinz Fassman

- 1992-1995: Director of the Institute for Urban and Regional Research (ISR) of the ÖAW;
- Since 2002: Member of the Academia Europaea;
- 2003-2009: Member of the Senate of the University of Vienna (Curia speaker professors);
- 2006-2011: Dean of the Faculty of Earth Sciences, Geography and Astronomy;
- Since 2006: Director of the Institute for Urban and Regional Research (ISR) of the ÖAW;
- Since 2007: Real member of the Austrian Academy of Sciences;
- Since 2009: Member of the Council of Experts of German Foundations for Integration and Migration (Berlin);
- Since 2010: Chairman of the Expert Council for Integration in the BMEIA;
- 2011-2015: Vice Rector for Personnel Development and International Relations, University of Vienna;
- 2015-2017: Vice Rector for Research and International Affairs, University of Vienna (Function period: 01.10.2015 – 30.09.2019) and;
- Since 08.01.2018: Federal Minister of Education, Science and Research. ■

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Photonic quantum technology for quantum computing, data protection and fundamental quantum science

The Quantum Information Science and Quantum Computation group at the University of Vienna, Austria, uses single quanta of light to explore fascinating phenomena ranging from the foundations of quantum physics to guaranteeing the data confidentiality and privacy in cloud computing, as this compelling analysis reveals

Privacy guaranteed by the laws of physics – what sounds like any cryptographers' dream has actually been shown to be possible using the special properties of quantum physics. In the Quantum Information Science and Quantum Computation Group at the University of Vienna, Austria, we strive to investigate how these concepts can be extended and applied to distributed quantum and classical computations by using photons, single quanta of light. However, our expertise in photonic quantum systems allows us to study an even broader field of research, ranging from the foundations of quantum physics to the practical challenges of building a full-scale quantum computer.

Photonic quantum computing

The race to build a quantum computer is and has been on for a while. Different physical systems among them photons, superconductors, ions and many more are intensely tested for their capabilities to be the fundamental building block of such a full quantum computer. Which system will turn out to be the most successful one is still an open question, but it might very well be a combination of some of the above. So why did our group choose to work with photons? Photons are stable, are not easily disturbed by their environment and move with the speed of light – these properties allow us to build small-scale quantum computers without the need for cryogenic temperatures, complicated isolation systems and vacuum chambers. But more importantly, due to their intrinsic mobility and stability, they are the most promising candidates for quantum communication – the exchange of quantum information between distant quantum processors. This is a fundamental component in any distributed computation – which is the focus of our research group.

Secure quantum computation

Since large quantum computers are technologically very challenging to build, they will most likely first be available in specialised facilities, whose owners one might not necessarily trust. Thus, techniques for secure quantum cloud computing will be required. Our group has shown the first implementation of Blind Quantum Computing, a concept that allows a client with limited quantum capabilities to delegate a computation to a quantum server without leaking input, output or the algorithm of the computations.

Inspired by these breakthroughs we have been pursuing the line of increased security by using quantum mechanics ever since. Most recently we have implemented a homomorphic computation, which is a computation on encrypted data, a concept impossible to do classically with comparable security.

Secure classical computation using quantum systems

Since full-scale quantum computers still face significant technical challenges and it will take some years until they become available to the general public we chose to investigate the intermediate step of hybrid quantum-classical computers, technologies which augment current classical computers using small quantum systems and their potential to increase privacy.

We could for the first time demonstrate experimentally probabilistic one-time programs, that can be executed one time and one time only. These programs are impossible to implement classically without the use of self-destructing hardware. We used them to implement a digital signature scheme, allowing a client to delegate the one-time power of attorney to a person of his or her choice.


Image: © Equinox Graphixs

Technological challenges of building a quantum computer

At the same time, we are still interested in building a photonic quantum computer, a challenge that requires us to work on three main areas: a source of photons, a circuit to perform the quantum computation and efficient measurement or detection of the photons. For the first part, we need sources of photons, from single photons to complex quantum states – the fundamental resources for our computations. Currently, we are pursuing several efforts, ranging from entangled multi-photon sources in the telecom regime, to sources of entangled photons with very different wavelengths to the analysis of new materials like graphene, for the use in sources.

Concerning the second part, the circuit, we are working on several approaches to integrate and therefore miniaturise our circuits. Rather complicated experimental setups can now be implemented and even manipulated on a single chip. For the last step, the detection we have acquired expertise in using state-of-the-art superconducting single-photon nanowire detectors, which can achieve previously unreachable efficiencies of over 90%.

"The race to build a quantum computer is on and it has been there for a while. Different physical systems among them photons, superconductors, ions and many more are intensely tested for their capabilities to be the fundamental building block of such a full quantum computer."

Investigating the fundamentals of quantum physics

Experimental quantum information is still very much influenced by the foundations of quantum physics. Indeed, in our group, we have several projects dedicated to experimentally testing foundational concepts. For example, we have been studying how to use single photons to investigate the interplay between gravity and quantum physics, as well as the role of causal orders in quantum mechanics.

A causal order is essentially a list stating the order in which events occur. Until very recently, it was assumed that causal orders were always fixed, but it turns out that quantum mechanics allows for the parties to act in a quantum superposition of both orders at the same time. In other words, quantum mechanics allows for causal orders to be indefinite. Our group was able to experimentally prove that quantum mechanics does indeed allow for indefinite causal orders and that indefinite causal orders can also be used to run a program using fewer computational gates than using a fixed order.

These results encourage us to keep investigating the fundamental and practical concepts of photonic quantum information and we are curious to see what lies ahead.

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Supporting and funding research in France

The French National Research Agency (ANR) is a public body which comes under the authority of the Ministry of Research, as this profile of the organisation by Open Access Government discovers

The French National Research Agency (ANR) is a public body which comes under the authority of the Ministry of Research. In short, ANR supplies funding for project-based research and has done so since 2010.[1]

Going into more detail, we know that ANR funds research in all scientific fields, in both basic and applied research, by means of an internationally compliant competitive peer review process. In addition, grant recipients include universities, public research organisations, and companies of all sizes.

> "The aim is to massively invest over the long-term in innovative S&T projects which will eventually be a source of growth and progress for the French economy.

The key challenges the ANR works on are part of the European Strategic Agenda, indeed, ANR has deployed and designed a variety of funding instruments to satisfy the needs of project-based funding in research communities and where public policy for research and innovation in France is concerned.

ANR's activities aims can be summarised as follows:

- Developing science and technology (S&T);
- Rallying teams around societal and S&T challenges;
- Speeding up knowledge creation and transfer, as well as fostering academic-industry partnerships;
- Promoting interdisciplinary dialogue and collaborative work;
- Preparing a new generation of talent and;
- Facilitating collaborations, both European and international.

Competitive, project-based research funding

It is also worth pointing out that annually, over 8,000 peer reviewers assist ANR by providing their expertise. ANR certainly appreciates their work in terms of their kind assistance in guaranteeing the selection of projects to an extremely high standard. The ANR teams finance, monitor and assist these projects, plus they prioritise the quality of service delivered to the scientists, as well as the speed of response, the procedural simplification and the frequent adaptation to new challenges.

Quality and ethics

ANR's code of ethics has always set out best practice guidelines, with which all people and organisations concerned with the agency's activities must comply with. This charter guarantees the transparency of processes, compliance with the research project selection criteria and sound management of public funds.

In 2014, ANR developed a policy for ethics and research integrity (lien vers la page policy for ethics and research integrity). The document details the basic principles to abide by when it comes to the exercise of research or such training activities, along with the duties and rights of those that evaluate, support and perform research work. This applies to applicant organisations, researchers and all those involved in the activities of ANR.

This policy adheres with the principles set out in the 'Singapore Statement on Research Integrity' (July 2010) and the 'European Code of Conduct for Research Integrity' published by the European Science Foundation (ESF). It also complies with the Statement of Principles for Research Integrity adopted at the Global Research

Council meeting in 2013 and the recommendations of the European Commission's funding programme Horizon 2020.

Peer review

Every year, no less than 8,000 peer reviewers assist ANR by giving their expertise. We know that the ANR selection process is based on the principle of peer review, which is in line with international standards for research project selection. To get to this stage, ANR depends on the assistance of external and regularly renewed panels of scientific individuals, as well as the widest possible range of scientific experts in the international community.

One point worth noting here, is that prior to being given access to a complete proposal file, the reviewers must sign a confidentiality agreement and state that they have no conflicts of interest and accept the principles of non-disclosure, as well as the management of conflicts of interest which are detailed in ANR's code of ethics.

It is true to say that these peer reviewers play a crucial part in the process for selecting AMR project proposals, in light of the fact that the conversations of the evaluation panels are based on the peer reviewers' assessment reports. No less than three peer reviewers' reports are needed for each project proposal and it is these important that assessments, whether consensual or contradictory in their opinions, should power the discussions of panels to reach the ranking of the proposals.

Investments for the Future

One final point to note in this analysis of the ANR's many activities, are the Investments for the Future programmes, launched by the French Government in 2009. In short, these are strategic initiatives which intend to boost French competitiveness by investing in research, higher education and vocational training, in industry and SMEs, plus in sustainable development and in expanding sectors, such as digital technology, biotechnology and nuclear energy – more of which the ANR's website explains to us in terms of how research efforts are essential for France's competitiveness, growth and employment in the future, along with a concrete example of how research can benefit society.

"Drawing on ANR know-how and expertise, the French Government has entrusted the agency with (the) management of the research and higher education component of the programmes."

"The aim is to massively invest over the long-term in innovative S&T projects which will eventually be a source of growth and progress for the French economy.

"In a global context, an investing effort targeted towards research and innovation is a prerequisite for competitiveness, growth, and employment."

"Part of the initiative also focuses on health and biotechnology, with a view to bolstering progress on specific areas of knowledge, developing new solutions and allowing for the anticipation, improvement, development and validation of new approaches in medicine and agronomy."[2] ■

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Fighting antimicrobial resistance: Exploring new tools to beat bad bugs

Based on fundamental research, young scientists at the IBPC explore new approaches to fight against the global threat of antimicrobial resistance, according to two seasoned experts from Institut de Biologie Physico-Chimique – CNRS

Today, 100,000 tons of antibiotics are mass-produced annually, and more and more pathogenic species have become antibiotic-resistant because of their misuse or overuse. Some bacteria developed resistance against almost all known chemotherapeutic agents and antibiotics. The World Health Organization (WHO) now considers antimicrobial resistance (AMR) as a "global threat", resulting in more than 700,000 deaths annually and that number might reach 10 million by 2050.

Moreover, the number of approved new antibiotics by the United States Food and Drug Administration has steadily been declining; with 17 new antibiotics for the period 1983-1987, to only two for the period 2008-2012. Consequently, the long-term economic burden of antibiotic resistance could be worse than that of the 2008 financial crisis: in the European Union alone, antibiotic resistance annually costs €1.5 billion in extra healthcare expenses and losses in productivity.

The Institute of Physico-Chemical Biology (IBPC) was built in 1930 by the Edmond de Rothschild Foundation. It has always strongly supported curiosity-driven fundamental and multidisciplinary research in all areas of biology. Its design by Jean Perrin, Nobel Prize in Physics 1926, foreshadowed what would later be the CNRS (National Center for Scientific Research) created ten years later. Over the last few years, young scientists in two laboratories (directed by Harald Putzer and Bruno Miroux), have made discoveries with potential applications to fight against AMR: i) ABC-F proteins, a new target for killing bacteria (Gregory Boël); ii) inhibiting efflux pumps for a more efficient antibiotic cure (Martin Picard) and; iii) amphipathic polymers for better vaccination (Manuela Zoonens).

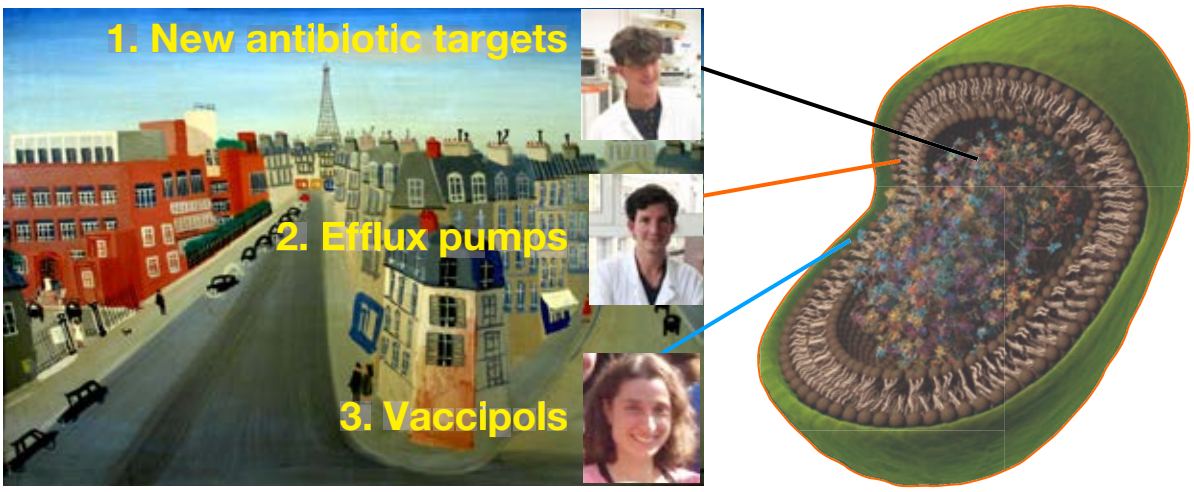
Targeting ABC-F proteins ribosome interactions

A large class of antibiotics targets the protein synthesis apparatus and close to half of them bind near the Peptidyl Transferase Center (PTC) and the polypeptide exit channel of the ribosome. As for the β-lactams, specific enzymes mediate AMR for the PTC targeting antibiotics. Several of them belong to the ATP-Binding Cassette (ABC) protein superfamily, which is mostly composed of membrane transporters that use ATP to couple transport. While some of them can simply pump the antibiotic out of the cell, other ABC protein families (ABC-F) lack transmembrane domains. We have demonstrated that one of them does not work as a transporter, but rather regulates translation according to the energy state of the cell[1].

The AMR ABC-F proteins provide resistance against all antibiotics that target the PTC or the polypeptide exit channel and most of those that act on the 50S ribosomal subunit, including linezolid antibiotics used in the treatment of vancomycin and methicillin-resistant strains. AMR ABC-F genes are present in mobile elements, such as plasmids and transposons and can thus be propagated rapidly. In order to understand how these proteins, induce antibiotic resistance, we study their mechanisms of action on the ribosome at the molecular level using structural, biochemical and genetic methods. This will lay the groundwork for new strategies targeting this protein family.

Efflux pumps

Efflux pumps are key players in AMR by transporting antibiotics outside of the bacteria. In Gram-negative bacteria, efflux transporters are organised as macromolecular tripartite machineries that span their two-membrane envelope. We have developed a unique reconstitution protocol to study in vitro their assembly and function in two-membrane environment[2]. Our project is to understand the dynamics of efflux pump assembly, the multidrug recognition and the mechanism of transport. Our methodology paved the way to the screening and the characterisation of efflux pump inhibitors (EPIs) that shall enhance or revive the efficiency of antimicrobials. Inhibition of bacterial efflux pumps increases antibiotic susceptibility and reduces the probability of emergence of antibiotic-resistant mutants.



New avenues to fight microbial infection

Given the very limited number of new drugs in the pipeline to fight multi-resistant bacterial strains, EPIs represent a promising alternative strategy. However, translation of lead EPIs into therapeutic compounds is a challenge because the cross-inhibition of human efflux systems can cause unexpected toxicity due to their multitude of physiological roles. Thus, selecting efflux pumps inhibitors operating only in prokaryotes may offer a greater chance of therapeutic success.

Vaccipols: a new amphipol-based vaccine formulation

Amphipathic polymers called 'amphipols' (APols) are mild surfactants useful for handling and stabilising membrane proteins (MPs) in aqueous solution[3]. Currently, most vaccines are prepared with live attenuated or inactivated whole organisms. However, some vaccines with a serovar/serogroup-specific protection may have a short-lived effect and may increase the number of infections or hypersensitivity reaction upon reexposure to the pathogen.

For these reasons, the search for a subunit vaccine combining appropriate antigens and adjuvants represents an attractive alternative. The usefulness of APols for vaccines has been demonstrated in a mouse model using as antigen, the native major outer membrane protein (nMOMP) of Chlamydia muridarum. The replacement of detergents for APols further enhanced the protection of mice against this pathogen likely due to a better stability and accessibility of nMOMP epitopes[3]. We are currently, developing APols with adjuvants to co-deliver antigen-adjuvant complex to the same immune cell. Our results show a further improved protection efficiency opening great perspectives in vaccine development.

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Reigniting Europe's leadership in debris mitigation efforts

Cenan Al-Ekabi, Research Fellow at the European Space Policy Institute (ESPI) explains the growing concern around orbital debris and the need to reignite Europe's leadership efforts

In the past decade, the count of trackable orbital debris has more than doubled, driven by collisions in space, several anti-satellite technology (ASAT) tests, the proliferation of CubeSats, a growing number of upper stages left in orbit and, in general, an intensification of the global space activity.

Today, around 23,000 objects reaching 10cm or larger are in the Earth's orbit, along with 750,000 objects under 1cm. While debris is a normal consequence of the exploitation of space, events such as the Iridium-33–Kosmos-2251 collision in 2009, which occurred near 800 km in altitude, will continue to aggravate matters since debris fragments will linger menacingly in orbit for decades before re-entering Earth's atmosphere, putting at risk manned spaceflight and operating satellites along the way.

While 93.7% of the rocket bodies and other debris in orbit is attributed to the United States, Russia and China combined, the loss of control of ESA's bus-sized ENVISAT satellite in 2012 put Europe in a new position with a risk of adding to the maelstrom if it is shattered by debris collisions.

Mitigating the growth of orbital debris is, even more, pressing with the increasing commercial activity and impending smallsat megaconstellations from SpaceX, OneWeb and others which would sextuple the number of operating satellites in LEO from the 1,071 in current operation as at 31 August 2017. If left unresolved, access to space and operations in space will continue to increase in complexity and to face growing threats, with the ultimate risk of losing the capacity to explore and use space.

Europe's Effort in the Field of Orbital Debris

Europe has proactively undertaken a variety of actions in the field of orbital debris mitigation, including strategic, policy and diplomatic efforts at European and international levels, but also programmes through national institutions, ESA and the EU to develop European capabilities in this field. Examples of the European effort include:

- In the legal domain, France, acting as a trailblazer, introduced its Space Operations Act in 2008 which requires all components of any space system launched from the CSG to be eventually deorbited in a controlled re-entry or to be put on a graveyard orbit by the "25 years" rule.

- In the operational domain, ESA formally launched its Space Situational Awareness (SSA) Programme in 2009 which addresses Space Weather, Near-Earth Objects and Space Surveillance and Tracking (SST). ESA also launched the Clean Space initiative aiming to promote and to develop technical solutions for, a responsible behaviour throughout the entire life-cycle of space activities, including removal of orbital debris.

The European Union also established an SST Support Framework in 2014 with the participation of Europe's largest national space players (France, Germany, Italy, Spain and the United Kingdom). In the diplomacy domain, the European Union launched an initiative for an International Code of Conduct for Outer Space Activities (ICoC) in 2008 to achieve enhanced safety and security in outer space through the development and implementation of transparency and confidence-build-

ing measures (TCBMs). European actors have also played a strong role in the development of the UN COPUOS's Space Debris Mitigation Guidelines, endorsed by the UN General Assembly in 2007.

In other domains, such as standardisation for example, the European Cooperation on Space Standardization (ECSS) recently adopted a new branch of standards for space sustainability including standards for space debris and space situational awareness with, for example, the requirement to ensure passivation of components at the end of life to avoid risks of explosion.

> "Mitigating the growth of orbital debris is, even more, pressing with the increasing commercial activity and impending smallsat megaconstellations from SpaceX, OneWeb and others which would sextuple the number of operating satellites in LEO from the 1,071 in current operation as at 31 August 2017."

Yet, additional European leadership will be needed to fully respond to the emerging space traffic challenges presented by various trends, including the incoming LEO mega-constellations and increased risk of collisions. Currently, Europe's SSA capabilities are limited and European agencies and operators must rely critically on data services supplied by the U.S. and other international partners to track smaller space debris.

Dependence on others for SST should raise concern at the strategic level. While the EU SST Support Framework is a good step toward filling in that potential gap, the current approach is viewed as too limited to provide the level of detail required to monitor smaller pieces in LEO and would require a much more substantial investment to develop a fully independent European SSA capability.

Conclusion: Breaking the international deadlock in debris mitigation efforts

While the international space community can agree that the mitigation of orbital debris should be made a priority, reaching the required global consensus on the steps to pursue seems unlikely in the near term. Because guidelines are unenforceable by nature, orbital debris mitigation rests predominantly on the amount of goodwill that states are willing to extend in voluntarily restricting themselves and their national operators from creating debris. Here the major space powers in this debate will likely continue to privilege their freedom of action in their activities over submitting to binding restrictions from international organisations, to ensure the security of their assets in orbit.

Since we are left with no choice but to accept this current status quo, where government activities are not bound by any kind of "hard law" or international binding agreement, we must continue to place our faith in the wisdom of institutional space players. Yet, the interests at stake would be different if the principals of the ICoC applied only to commercial activity. Here, even the major space players could reach an accord, so long as the arrangement does not bias the international competition – i.e. the same rules would need to be applicable to all private operators worldwide and would require proper enforcement mechanisms to ensure their correct implementation. This could be a sound basis for a revised ICoC, limited in scope to commercial activities, but addressing the most critical and worrisome challenges anticipated with the increase in space traffic. ■

Available for download from the ESPI website: www.espi.or.at

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CMB Space missions: a window to astroparticle physics

Prof. Nicola Vittorio from Università degli Studi di Roma 'Tor Vergata' gives an absorbing insight into CMB Space missions and why they are a window to astroparticle physics

Input stress[1] on the great goal of modern cosmology: investigating the physics of the early universe. This very ambitious goal requires combined and synergic contributions from astronomy, particle physics and cosmology. These three research areas are progressively converging into a relatively new research field called astroparticle physics, which simultaneously addresses fundamental questions connected from one hand with the elementary particles and their interactions but, on the other hand, with the formation and evolution of the large-scale structure of the universe.

In 2001, the Astroparticle Physics European Consortium (APPEC) was founded to promote cooperation among the members of the European scientific community and coordination among the national (European) scientific agencies. This was (and is) perfectly in line with the need and the effort to build a European Research Area (ERA), as clearly stated in 2011 by the European Council. This is obviously crucial to fully capitalise on Europe's scientific and creative potential.

An ERA Roadmap at EU level was endorsed by the Council in 2015, calling for a limited number of top action priorities. Although transnational cooperation between the Member States has increased along with an improvement of all the indicators for research excellence, there is still much to do. This is why it has been particular timing the presentation of the European Astroparticle Physics Strategy by APPEC the 9th January 2018, in Brussels, Belgium.

The APPEC Recommendations for the 2017-26 address specific scientific issues and updates of long-term scientific strategies, as well as societal issues like global collaboration, community building, gender balance, education, public outreach and relations with industry. Among these recommendations, there is the recognition that: "The future Cosmic Microwave Background (CMB) programme sets the stage for a range of opportunities to link key themes together and provides a potential stepping-stone towards further fundamental discoveries".

Interestingly enough, the properties of the galaxies and their spatial distribution, as observed "here and now", are determined by the physics of the inflation, a period of accelerated expansion occurring in the early Universe just (10^{-36} seconds) after the conjectured Big Bang. Inflation is nowadays considered the paradigm solving some fundamental shortcomings of the hot Big Bang model and, most of all, providing the only self-consistent mechanism able to explain the generation of the primordial seeds out of which (via gravitational instability) all the observed cosmic structures have formed.

The CMB is certainly the most powerful and natural tool to characterise these seeds and to constrain models of particle physics beyond the standard model at energies which will be never reached in laboratory experiments. In particular, tensor perturbations of the space-time metric lead to a primordial gravitational wave background, which imprints a unique pattern (the so-called B-modes) in the polarisation of CMB photons. Therefore, the primary scientific exploitation of CMB B-mode detection will aim to a definitive probe of the inflation paradigm and, hopefully, to elucidate the physical mechanisms behind it.

In addition to this, the gravitational lensing of CMB photons due to the large-scale matter distribution will provide stringent information on the distribution of dark matter and, possibly, on the masses of neutrinos. The comparison between the neutrino properties inferred from cosmological measurements and those determined in laboratory experiments is likely to open a new window on our physical modelling of the micro- and macro-cosmos.

To discover the secrets hidden in the B-modes of the CMB, it is necessary to combine observations from space and from the ground. The ongoing and forthcoming ground-based CMB experiments[2] use large detector arrays and reach high angular resolution.

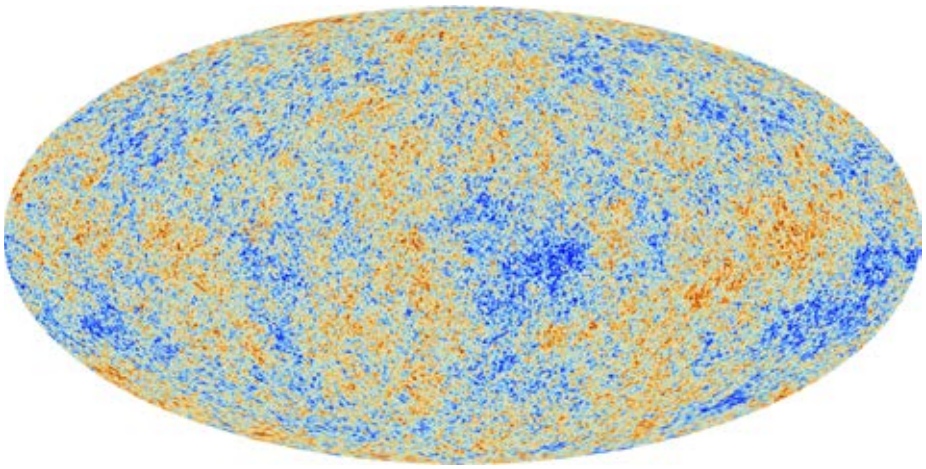

Image: http://www.esa.int/spaceinimages/Images/2013/03/Planck_CMB

The CMB is the oldest light reaching us "here and now". The ESA/Planck observations of this light show tiny intensity fluctuations that bring information on regions that had slightly different densities when the universe was 380 000 years old. The existence of these regions explains the large scale structure of the universe we observe today

Space-borne CMB measurements are not limited by the atmosphere and can probe a wide frequency range to provide an effective foreground subtraction to reveal the truly primordial B-modes induced by the primordial gravitational wave background.

The last space experiment dedicated to CMB observations is the ESA/Planck mission, which has created a CMB community in Europe with a unique expertise in space-borne CMB research. After the completion of Planck and the forthcoming Planck Legacy release, European CMB researchers have continued to play leadership roles in a number of suborbital efforts – both in Europe (e.g., Qubic, LSPE, Pilot) and elsewhere (e.g., by collaborating with the ground-based S4 program) – but still looking for a shared, major European experimental effort.

The European CMB community has also recognised the need and the urgency for a new space mission. There was quite a strong R&D effort in Europe in new technologies for the next generation CMB experiments and a proposal for a Core mission submitted to ESA has been, unfortunately, rejected. Therefore, LiteBIRD (Lite satellite for the studies of B-mode polarisation and Inflation from cosmic background Radiation Detection) – a JAXA's strategic large mission candidate in Phase-A1 (concept development) – appeared to the European CMB community a natural and logical continuation of these Europe-led efforts.

At the national level, there is an interest to contribute to LiteBIRD from CNES in France, from both the UK Space Agency (UKSA) and the UK Science and Technology Facilities Council (STFC) and from the German Aerospace Center (DLR). The Italian Space Agency (ASI) has already founded the participation of the Italian CMB community to the LiteBIRD Phase A1 study, which will end by the end of this year.

Further interest at the European level has been manifested by Spain, the Netherlands and Finland, along with Sweden. To facilitate a coordinated effort of the European community during the Phase A1 of the LiteBIRD experiment, there is the willingness to constitute a European Consortium. The governance structure of this Consortium will be finalised during the forthcoming Turin Meeting (8th-9th February 2018). This structure will be revised once the LiteBIRD mission will be approved and the so-called Phase B will start, early in 2019.

The participation of the European CMB community in LiteBIRD was solicited by a formal letter of the ISAS/JAXA Director-General. A potential junior partnership of ESA on the JAXA-led mission LiteBIRD could be realised through a Mission of Opportunity (MoO), if there is a clear scientific return to ESA's scientific community. However, ESA cannot approve a MoO before LiteBIRD is formally selected by JAXA.

So, while there is the need of not dispersing knowledge and skills acquired with the ESA/Planck mission, the formal selection from JAXA of the LiteBIRD mission seems to be the appointment not to be missed by the CMB European community.

See the link to my last book here, which was published in late 2017.

1 Open Access Government May 2017, pp 102-103

2 Open Access Government August 2017, pp. 182-183

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Ensuring a globally successful European space sector

Johann-Dietrich Wörner, Director General of The European Space Agency (ESA) shares his views on ensuring a globally successful European space sector

In this interview, Johann-Dietrich Wörner, Director General of The European Space Agency (ESA) shares his thoughts on the extent to which European spirit, identity and cohesion are the overarching aspects for Europe to achieve the best of outcomes for its states and citizens in space and for a globally successful European space sector.

As a European, Johann-Dietrich Wörner, Director General of The European Space Agency (ESA), starts by explaining that the idea of the United States of Europe is a very good idea, in his opinion. This notion is one that he inherited from his parents and also echoes the thoughts of Winston Churchill (Prime Minister of the United Kingdom from 1940 to 1945 and again from 1951 to 1955).

Wörner adds that today, we are not even close to this notion in terms of the borders within Europe, but he emphasises that the United Space in Europe is something that can be achieved. He turns this around, however, by sharing his belief in a United Europe in Space, a point he is keen to explain further to us.

"Europe should be united at least in space, by working together not only within the borders of Europe but on a global scale. As such, we are working with Russia, the United States (U.S.) and China – knowing that in each case there are political problems here and there. If we look to Europe, we have the development of Brexit in the UK, but the country remains a partner of ESA which we are very happy about, therefore, ESA can contribute towards a United Europe in Space."

Going into more detail about the United Space in Europe concept, Wörner underlines the intensive cooperation of different European entities for the sake of strengthening Europe. He draws our attention to the clear European vision contained in the ESA Convention, signed in Paris on 30 May 1975 by the nine original member states – Belgium, Denmark, France, Germany, Italy, the Netherlands, Spain, Sweden and the United Kingdom.

"The father and mother of the ESA Convention thought about how we can realise that Europe is really working together, and they invented an instrument, which people are still fighting against. Whenever a member state of ESA puts a certain amount of money into a special trust, we are directly supporting industrial policy in the member states. All our projects are multi-national and, in many cases, cover all ESA member states. Sometimes this is not the cheapest solution, but the European spirit we get by that approach leads to identity and cohesion, which are the overarching aspects for Europe to achieve the best of outcomes for its states and citizens in space and for a globally successful European space sector.

"One of the objectives we defined concerns the full integration of space into the economy and society, one was for the strength of the competitiveness of Europe's industry and academia, plus another was to have the economy working in selected areas. So, we are doing that for all our member states plus beyond, including Switzerland, Norway and the UK – so our parameters when we discuss what we are doing in Europe goes beyond what we know as the European Union (EU) today.

Next, Wörner tells us how the ESA perceives the new playing field in the European space sector today, which comprises governments, the private sector, as well as society and politics. He stresses that during the 20th century, we had the race into space during the 1950s and 60s. This, of course, was a race into space between the governments of the Soviet Union and the U.S. However, today there is competition between a number of countries, he highlights.

Image: © ESA - P. Sebirot

Johann-Dietrich Wörner, Director General of The European Space Agency

"Today, we do not have this race into space, but we still have some competition between national countries inside and outside Europe. I always say that competition is always a driver, as in sport when it makes something better. Cooperation is an enabler, so when we are competing in Europe, then it is good because it is driving innovation.

"When we are cooperating, we can suddenly do things that an individual country cannot do alone or afford, such as going to Mars. Therefore, cooperation is an enabler and competition acts as a driver and to play both at the same time is not that difficult. This is a modern approach for the development of society itself."

Wörner then shares with us the challenges that lie ahead to proactively develop the different aspects of Space 4.0, which represents the evolution of the space sector into a new era, characterised by a new playing field. 'Space 3.0' is where we are at now in terms of international cooperation and new approaches, which has been the focus of this interview. Wörner concludes with his thoughts on Space 4.0, which is intertwined with, Industry 4.0, the unfolding fourth industrial revolution of manufacturing and services.

"Looking to the future, for example, in the U.S. they refer to new space when they are talking about more commercialisation – in terms of the non-space sector entering the space sector. This is part of Space 4.0 concept, as is the participation of citizens. ESA did a citizen debate two years ago and we will do another one in 2019 because we want to leave participation with normal citizens which is a very important part of ESA's work.

"Diversity is part of Space 4.0 concept; indeed, ESA's work is very diverse with 22 member states involved plus Canada and Slovenia. Technologies also belong to Space 4.0, such as 3D printing in space, or quantum entanglement, therefore, the concept is covering an umbrella of work and I am sure that the future of space will be found within Space 4.0." ■

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Multiverse theories in physics from the vantage point of philosophy

Dr Simon Friederich from University College Groningen sheds light on multiverse theories in physics from the perspective of philosophy

Are there regions of space and time where the laws and constants of nature are different? Are there perhaps even separate universes with different laws and constants? A collection of real universes with differing laws and constants is called a "multiverse" and the question of whether we might possibly live in a multiverse is a hotly debated one among physicists.

While some physicists are enthusiastic about the multiverse idea, others are extremely critical. The critics point out that it is impossible to empirically access other universes – if they exist – and they argue that this makes theorising about other universes pseudo-scientific.

But there are two important reasons why we might want to seriously consider the multiverse idea nevertheless:

1. Developments in string theory and inflationary cosmology, when combined, suggest a version of the multiverse idea. Inflationary cosmology is the dominant paradigm of early-universe cosmology. Some implementations of it picture the early universe as expanding (near-) exponentially fast, resulting in causally isolated space-time regions: so-called "island universes."

String theory is perhaps the leading approach to unify our best theories of particle physics and gravity. When combined with inflationary cosmology, it suggests that different island universes may realise different string vacua. The latter would manifest themselves in different effective laws and constants across universes, resulting in an independently motivated concrete implementation of the multiverse idea.

2. According to many physicists, the laws and constants in our universe seem fine-tuned for life: had they been slightly different, life might not have existed. It is often claimed that the proper reaction to this finding is to infer that there is a multiverse. The reasoning behind this suggestion is that, if there are many universes with different laws and constants, it is only to be expected that there are at least some with the right laws and constants for life. Since we can exist only there, it is then no wonder that we find ourselves there. So, the existence of a sufficiently vast and varied multiverse would seem to explain why there is life and why we exist despite the required fine-tuning.

The inference from fine-tuning for life to a multiverse has been criticised by some philosophers. According to them, it commits what is called the "inverse gambler's fallacy": inferring from one remarkable outcome that there are likely many similar events, with less remarkable outcomes. For example, the inverse gambler's fallacy is committed by someone who enters

a casino, sees a rare and remarkable outcome happen at the next table and concludes that the game has likely been going on for a long time because one remarkable outcome among many non-remarkable ones would all in all, not be very surprising. According to critics of the inference from fine-tuning for life to a multiverse, it commits the same fallacy: the existence of other universes would not make it any more likely that this universe here has the right conditions for life.

Whether or not the inverse gambler's fallacy charge against the standard fine-tuning argument for a multiverse is compelling or not, it is interesting to note that one can make a novel fine-tuning argument for a multiverse that is not potentially vulnerable to it. That argument starts with the observation that single-universe theories usually start out with the advantage over multiverse theories that they allow more specific predictions. Multiverse theories tend to entail so many different things happening in the different universes, that this seriously hampers their predictive force.

But if the laws and constants must be fine-tuned for being life-friendly, that advantage of single-universe theories over multiverse theories is reduced: for if we can already derive from the fact that there is life what the laws and constants had to be, predicting those laws and constants is no longer such a great achievement for a physical theory. Thus, the fine-tuning considerations partly undercut the main advantage that single-universe theories have over multiverse theories and, so, incrementally shift the balance of rational belief in favour of multiverse theories.

But do we even have a chance to empirically test specific multiverse theories like the one based on inflationary cosmology and string theory? Unfortunately, doing so is incredibly hard, especially for theories that suggest multiverses that are sufficiently vast and diverse to make the existence of a universe like ours likely. The problem is, that such theories will also make the existence of other universes likely that are radically unlike our own, which makes it difficult to see what – if anything – we should expect to observe if such a theory is true: so many conceivable observations are compatible with it.

> "A collection of real universes with differing laws and constants is called a "multiverse" and the question of whether we might possibly live in a multiverse is a hotly debated one among physicists."

The most widely used strategy for extracting predictions from multiverse theories, despite this difficulty, is to focus on what typical multiverse inhabitants observe. However, an obvious problem with this strategy is that it presupposes an answer to the tricky question of what counts as an observer. Put differently, the question is with respect to which reference class of objects, conceived of as observers, we should assume being typical. In practice, this difficulty is usually avoided by using a "proxy" for observer number, for example, the amount of matter clustered in giant galaxies.

For the multiverse scenario based on string theory and inflationary cosmology, a further necessary step is to choose a so-called "cosmic measure", to make comparisons between observer numbers in the different sub-universes well-defined. The main criterion to assess any suggested choice of observer proxy and cosmic measure is whether it leads to empirically confirmed predictions. But, unfortunately, making the choice of observer proxy and cosmic measure dependent on whether it leads to successful predictions, drastically decreases the value of such predictions. Thus, as long as an observer proxy and a cosmic measure must be specified, it is very hard, perhaps impossible, to produce compelling empirical support for specific multiverse theories.

To conclude, while the multiverse idea is well motivated, conclusively testing concrete multiverse theories will likely remain out of reach in the foreseeable future of physics.

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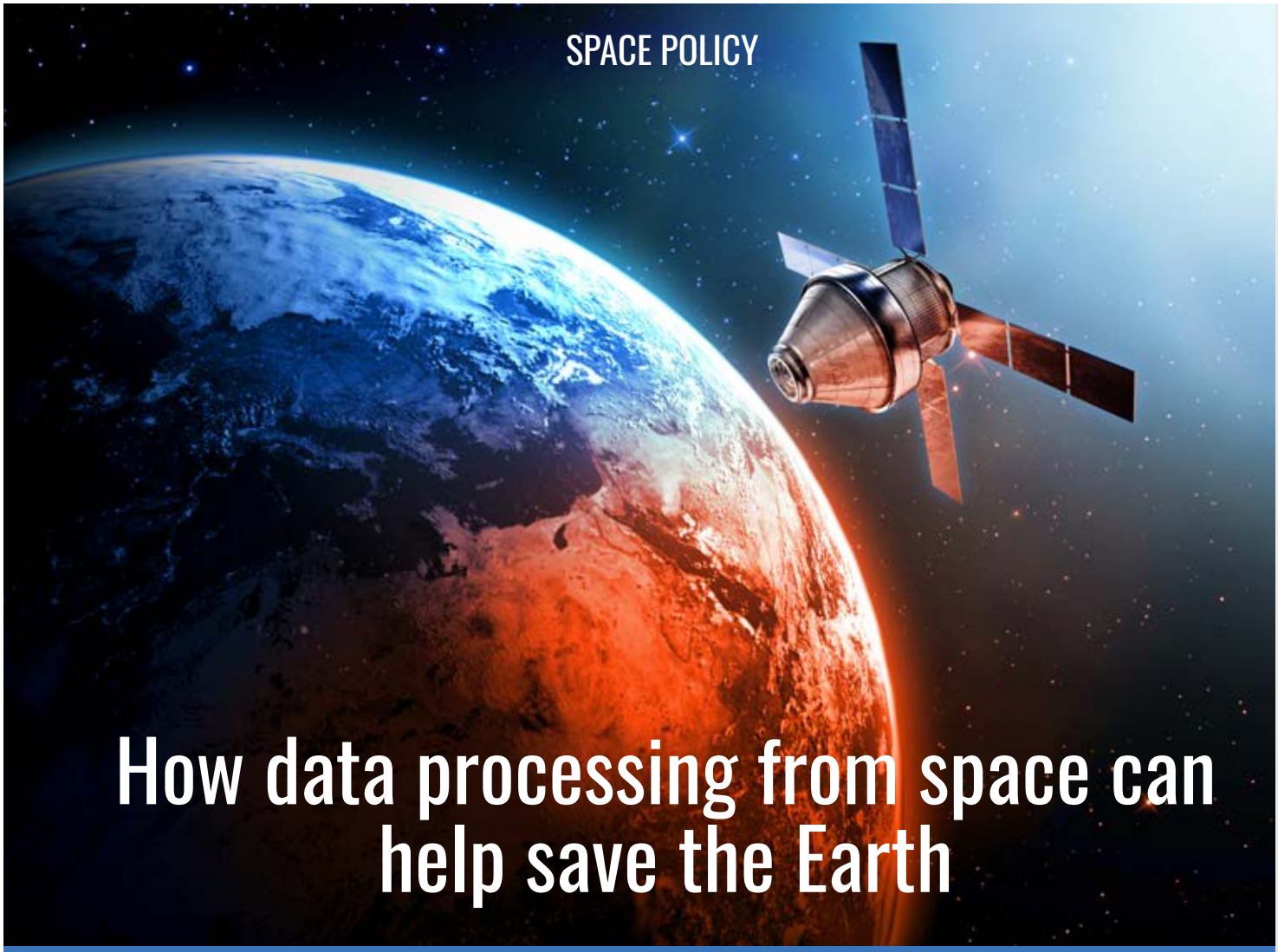

How data processing from space can help save the Earth

Michał Baćkowski, Managing Director, KP Labs part of FP Space shares his expert perspective on how data processing from space can help save the Earth

According to information compiled by the National Oceanic and Atmospheric Administration, NASA, the UK Met Office and other Earth temperature-monitoring groups, 2017 was the warmest year to occur without an El Niño event. Along with plenty of other warnings, these findings should caution us that conditions on Earth are changing at a rate that is becoming increasingly hard to control and monitor.

However, by using a new, previously underestimated ally – data processing, climate change scientists may be able to monitor changes in ways they haven't before. This data processing will not occur on Earth, it will take place in space instead.

Advanced data processing in space is now capable of monitoring agriculture, environmental protection and geology down on Earth. This has the potential to significantly expand our knowledge of what damages the environment, how this change occurs and at what pace this devastation takes place. With the help of satellite technology and specialised hyperspectral imaging cameras, this is becoming possible.

However, what earthly insights do data processing and satellite technology give us from up above?

Forestry

Thanks to dividing a spectral resolution of satellite images in the range of visible and near-infrared light into 150 channels, we will be able to obtain much more information from those images than before. While satellite technology could previously only offer 40 channels across the visible to near-infrared spectrum, new advancements allow us to cover forest classification, identifying species, the health condition of forests and forestation planning.

Data collected in this way will allow for a more balanced forestry policy and, as a result, a better and more efficient planning of the ecosystem management.

Environmental protection

Both conventional machine learning (including feature extraction, support vector machines and artificial neural networks) and deep learning (including data augmentation and a selection of hyper-parameters of deep neural networks) can produce pollution emission maps, water and soil pollution maps and land development management and analysis.

> "Advanced data processing in space is now capable of monitoring agriculture, environmental protection and geology down on Earth. This has the potential to significantly expand our knowledge of what damages the environment, how this change occurs and at what pace this devastation takes place."

By using machine learning and algorithms working on the level of water eutrophication based on multispectral satellite imaging, we can monitor lakes with an efficiency that will allow us to deliver valuable information used for the overseeing of water basins, such as drinking water reservoirs. This is mostly around mitigating risks connected with water pollution which will translate into a lower risk of epidemics.

Geology

Data obtained from microsatellite technology can also be used for land coverage classification, creating mineral distribution maps, monitoring mining and post-mining areas, detecting pollutants penetrating the water and land, the possibility of detecting heavy metals such as cadmium, lead and arsenic based on a spectral signature.

In recent times, satellite technologies have been increasingly popular for the development of the mining industry. Satellite technologies allow mining companies for a better use of resources and cutting production costs. An important aspect is also the safety of employees and local communities.

Data processing from satellites has the capability to monitor environmental changes over longer durations than monitoring technology on Earth and can detect the exact moments when forest and geological health starts to deteriorate, far more easily. Over three times the number of light spectrums gives us far greater access to these processes, when they occur and how often. And what's most exciting is that the satellite wielding this technology could be ready for launch into low-orbit by 2022, monitoring all the information we'd need by December 2023.

An example of a company working on this technology comes from Poland. KPLabs, which, together with Future Processing and FP Instruments, belongs to the FP Space consortium, is working on a satellite which will be equipped with a hyperspectral instrument and advanced data processing onboard using deep convolutional neural networks.

The Intuition-1, as it's called, aims to be the first satellite in the world with the processing capacity that makes it possible to segment hyperspectral images in the orbit. The segmentation of images onboard the satellite will allow for a more effective communication and will shorten reaction time for events we want to monitor. The next stage of the project is Intuition-2, which will be a constellation of 12U satellites, all equipped with HyperCams. This will significantly increase the earth observation range.

With these technological developments close to completion, the future of space is exciting, but the future of Earth is even more so. ■

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Microbes and the rigour of space flight

William B. Miller, Jr., M.D. argues that without the planning to do so, we have launched microbial life from this planet

It was the greatest car ad ever conceived. A red Tesla Roadster was launched into space with a jaunty spaceman mannequin at the wheel. As it streaks around our solar system at speeds of seven miles per second, its dashboard screen reads a playful, 'Don't panic'. Initial press coverage was fawning. The biggest question was, "Is this art or advertising?" It was never mentioned that the car and its mannequin are loaded with microbes. There hadn't even been any real attempt to clean it prior to launch. No big deal. It's just floating in space and won't impact a planet for a million years or more.

However, its elliptical orbit around the Sun has it crossing Mars orbit every 18.8 months. It will often get close. No one seems to care that this craft will gradually deteriorate over time from the impact of innumerable micrometeorites during its endless loops throughout the solar system. And no one seems to understand that particles of those micrometeorites will ricochet off the car and mannequin and carry bits and pieces of it wherever they go. And no one has noted that on every minuscule bit, there will a new set of travelling companions. Wherever those particles go, associated microbes will now circulate with those particles, some of which will travel outward for light years.

It is the same for all the NASA spacecraft that have ever been launched. To NASA's credit, they have tried to be careful. NASA has been rightfully concerned about the possibility of sending our planetary life out into space. To that end, they enacted rigorous 'clean' rooms. Prior to launch, vehicles were carefully scrubbed to get rid of any lurking microbes. When our spacecraft was launched, they were thought to be sterile. Unfortunately, what NASA believed to be true, was not. It is now under-

stood that the culture techniques that NASA relied upon to determine sterility were utterly insufficient.

In our contemporary era, there are new tools of genetic assessment that permit our identification of a much wider range of microorganisms than in prior decades. In fact, it is now known that fewer than 10% of all microbes can be cultured in the standard manner that NASA was diligently applying. Therefore, the tests that NASA relied upon to issue their declarations of sterility were unfortunately completely inaccurate. Although the NASA spacecraft were culture negative upon launch, they were abounding with covert microbial life.

Furthermore, we now know that many microbes can withstand every rigour of space flight. In the vacuum of space, with its absolute cold and bursts of destructive radiation, humans would instantly die. Yet, some microbes do not, nor do singular small animals, called Tardigrades. These incredibly resilient microscopic eight-legged creatures can withstand all the extremes of space. We know that this is true since some of them have even survived re-entry back to our planet from other space flights.

It is these exact findings that inform us that single most important event in our entire human history is currently transpiring. This unheralded event is the passage of the Voyager 1 and 2 spacecrafts beyond our solar system and exiting into interstellar space. What makes this passage so momentous is that both crafts carry life.

As originally envisioned, the mission of the Voyager spacecraft was to study the outer planets of our solar system. In this regard, that mission has been highly successful. The Voyager craft left Earth in 1977, arrived at Jupiter in 1979 and then passed by Jupiter, Saturn and Uranus, to arrive at Neptune by 1989. Important physical discoveries were catalogued at each planet, such as the magnetospheres of Uranus and Neptune. By mission design, there was never any possibility of return. Instead, the craft was tasked towards an endless continuation into deep space.

Now, Voyager 1 is over 13 billion miles from Earth, with Voyager 2 close behind. Currently, they are just at the margin of the heliosphere which is the large zone influenced by our Sun. Thereafter, interstellar space looms and the Sun's influence rapidly fades.

Although the milestones of the Voyager craft are being minutely detailed, NASA astronomers remain completely silent about the most portentous aspect of this Voyager mission. That silence is not entirely surprising since, until the Tesla car launch, the Voyager mission represents the most egregious example of unintended consequences in human history.

Though this event receives no attention, it is immensely more significant than any war in human history, or any ideology, or all our art and culture. Without planning to do so, we have launched microbial life from this planet. Now, for endless eons, that tenacious life will be propelled outward into deep space. Everywhere Voyager goes, life will be shed. It is the same, but even more so, for the supremely egotistical Tesla in space. Both are instances of singular technical achievement and delinquent government oversight.

There is a theory of the origin of life that suggests that it began on Earth as an instance of Panspermia. In effect, life on this planet began elsewhere, finding a home here and thriving. Now, without explicit intent, both Voyager spacecrafts and the Tesla advertisement have begun the process of seeding of life throughout the Cosmos. In our uniformed hubris, we have become an unintentional agency of Panspermia. Now, in a direct sense, we have become a Cosmic invasive species.

Let it be our earnest hope that we will be forgiven. ■

Dr Bill Miller had been a physician in academic and private practice for over thirty years. He is the author of The Microcosm Within: Evolution and Extinction in the Hologenome. Dr Miller is an internationally recognised evolutionary biologist and an expert on the emerging science of the microbiome. He is the author/co-author of numerous academic papers on the microbiome and evolution, serves as guest editor of a major academic biology journal and is co-editor of a forthcoming textbook on developmental and evolutionary biology. Connect with him on Twitter, @billmillermd.

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How developmental biology changes our lives

Shyh-Jye Lee (Jeff), Ph. D, President of the Taiwanese Society of Developmental Biology (TSDB)
explains the way in which developmental biology impacts upon our lives

Developmental biology (DB) is an expansion of traditional embryology, which studies the development of a single-cell fertilised egg to a multicellular free-living organism. Today, DB research covers beyond embryogenesis to include growth, sexual maturation and ageing.

DB affects our life in many aspects. One of the key issue related to our life and the sustention of species is the control of fertility and infertility. The understanding of oestrous cycle and the development of sexual organs and gametes helps us control conception and increase fertility. Birth control pills and condoms are both effective tools for population control. The development of in vitro fertilisation (IVF, i.e. test-tube baby) technology is another good example to show how DB research can change our lives. The desire of having their own baby was often a dream that never came true for infertile couples.

But since the development of IVF and other assisted reproductive technologies, many couples regain their hope to have biological babies. The success of IVF in mammals, including human, was based on the basic understanding of fertilisation mechanisms of marine invertebrates like sea urchins. From those studies, we appreciate the importance and regulation of ionic flows during fertilisation. By manipulating those factors along with others, scientists gradually broke through the IVF barriers in mice, human and other larger mammals. IVF is thus one of the most fascinating stories of how DB research can improve the wellbeing of human life itself.

How could a single-cell fertilised egg develop into a multicellular functional adult is a key fundamental question asked by developmental biologists. Throughout centuries of research, we understand that cells in early-stage embryos have the full potential to become all types of adult cells that are called “totipotency”. The totipotency is gradually lost in later stage embryos, but they still retain “pluripotency” to become multiple types of cells. Eventually, embryonic cells limit their developmental potential to one specific type of cells. However, we know that even terminal differentiated somatic cells contain the same genome as that of a fertilised egg.

Theoretically, it can be totipotent if properly reprogrammed back to the original state. Although the astounding generation of Dolly Sheep proves the principle by somatic nuclear transplantation experiments, low success rate and unhealthiness of cloned animals imply that reprogramming the differentiated genome to its default state is not reached by using this method.

Many animals, like planarians, salamanders and zebrafish can replace missing body parts. In contrast, mammals only have a limited regenerative ability in tissues and organ-like skin epithelial layers, hair and liver. This may lead to severe health problems like fibrosis, accumulation of extracellular matrix proteins like collagens in heart and other organs. Heart injuries often lead to scars and subsequent fibrosis. Fibrosis results in the stiffness of heart, impaired function and eventually heart failure.

The studies of fibrosis prevention and resolution have attracted the attention of medical professionals, as well as DB researchers. DB researchers often use animal models capable of regeneration to understand how the regeneration is induced and accomplished. They are now more eager to apply the gained knowledge to screen drugs or devise tools or strategies to repair injure tissues or organs in mammals and human that have been established in a new discipline called “regenerative medicine”.

During development, a group of cells called stem cells not only can become other types of cells, but they can renew themselves to keep their stemness. The most competent stem cells are embryonic stem cells (ESCs). ESCs are cells from the inner cell mass of a blastocyst. They contain pluripotency that allows them to be induced into many other types of cells in vivo or in vitro and is potentially a great cell source to be cultured to tissues, or even organs to be used in regenerative medicine.

"Developmental biology (DB) is an expansion of traditional embryology, which studies the development of a single-cell fertilised egg to a multicellular free-living organism. Nowadays, the DB research covers beyond embryogenesis to include growth, sexual maturation and ageing."

However, it is unavoidable to destroy a blastocyst while collecting ESCs. It becomes a major hurdle that prevents the practical use of ESCs due to ethical and religious reasons. Terminal differentiated somatic cells still retain the same genome as that of fertilised eggs. Triumphantly, we now can reprogram somatic cells like fibroblast cells to become stem cells called inducible pluripotent stem cells (IPSCs). Using IPSCs different types of cells, including blood, neuronal cells, muscle cells, germ cells and others have been created in vitro. The next challenge will be how to consistently produce those cells to be reliably used in regenerative medicine.

IPSCs may also push the development of medicine to the next level. Traditionally, the development of drugs relies heavily on the use of immotile cell lines and animal models, mainly mice. However, only less than 1% of drugs tested in clinical trials are approved. The failure of drug testing can be for a variety of reasons. The suitability of screening model is certainly one of the issues. Although mice resemble human in many ways, they are not human. Even in humans, there are variations between different people.

In addition, drugs entered the market are suitable for most people that may not fit you well. Therefore, the idea of "precision medicine" emerges. The IPSCs may fit in the precision medicine nicely. We can use patient-derived IPSCs for drug testing before administrating to patients. We can also use human-derived IPSCs for drug screening as well. However, we still have a long way to go and proper animal models are still needed.

Shyh-Jye Lee (Jeff), Ph.D.
President

One of the most exciting discoveries in biology lately is the invention of CRISPR/Cas9 technology, which allows much more convenient targeted genome editing in cells and organism levels. DB researchers quickly apply this technology to edit genomes of different model systems, as well as for IPSCs. It is then of great potential to correct human genetic diseases with known mutation(s) using CRISPR/Cas9 if it is proven to be safe and effective in the future.

Overall, although most DB research still focuses on the basic regulations of developmental processes, developmental biologists are prompt to apply their findings for practical use in both medicine and agriculture. So far, many great discoveries have been made that have affected our lives, but I can only name a few here. To go further, we will need more efforts from DB researchers, along with continuing support from governments, the private sector and the public. ■

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Rediscovering observations of the environmental factors affecting tissue regeneration in aquatic species

Graciela A. Unguez, PhD, Professor of Biology and student Bahiyyih Mitchell at New Mexico State University explore the environmental factors affecting tissue regeneration in aquatic species

What controls the regeneration of entire body parts and organs in some animals, even multiple times in adulthood? This "million-dollar" question has fuelled the curiosity of many scientists for centuries. Today, the number of both terrestrial and aquatic species tested for their response to injury continuously grow, expanding the comparative analysis of regeneration capacities throughout the animal kingdom.

At the same time, the availability of molecular approaches and tools to manipulate genomic sequences has driven the focus of scientific studies towards elucidating the genetic basis of regeneration processes. This has led to a growing identification of distinct molecular switches and signaling pathways that activate or inhibit stem cell progenitors and other cellular mechanisms of tissue regeneration[1-2].

However, and perhaps unintentionally, the emphasis on establishing model systems amenable to genetic manipulation under controlled lab conditions has led many of us to overlook and/or underestimate the environmental effects on regeneration.

A case in point is the effect of artificial light exposure on tail regeneration of the gymnotiform electric fish *Sternopygus macrurus*. *S. macrurus* is a highly regenerative species and our lab has exploited this property to characterise the differentiation of myogenic cells in response to repeated tail amputations, the effect of neural input on the differentiation of myogenically-derived cell types and the activation of myogenic stem cells to restore original skeletal muscle and muscle-derived electrogenic tissue lost[3-6].

Surprisingly, we recently performed an experiment in which 12 adult fish had their tails amputated, but none of the fish regenerated a blastema as expected even two weeks after amputation. These fish had been kept in a room adjacent to the main aquaria room. Upon return to their original tanks in the main aquaria, these fish began regenerating their tails. This observation led us to hypothesize that decreases in light exposure negatively affected tail regeneration in *S. macrurus*. *S. macrurus* fish (n=5) were then placed in either constant darkness conditions or on a control 12hr-on/12hr-off light cycle condition (Figure 1) and regeneration blastema length measured seven and 14 days post-amputation.

In general, regeneration blastemas from fish kept in restricted light or "dark" conditions appeared smaller than those in control lighting conditions at seven and fourteen days after tail amputation (Figure 2). Quantitation of cell proliferation in regeneration blastemas under control and dark conditions using the 5-ethynyl-2'-deoxyuridine (EdU) labelling assay

Figure 1: Experimental lab setup to modify external lighting conditions.

Top Row: Fish in the Control group were housed in individual tanks and had no changes in ambient light exposure.

Bottom Row: Fish in the Restricted Lighting or "dark" group were housed in individual tanks and their exposure to light was greatly reduced by covering their tanks with thick black plastic bags.

showed mean lower numbers of EdU-positive cells in blastemas from fish kept in dark, compared to that of fish in control lighting conditions.

These observations led us to our rediscovery of a study published in 1977[7] on stunted forelimbs of newts *Triturus* (Notophthalamus) *viridescens* when these were kept in constant darkness following limb amputation. Specifically, animals exposed to continuous light reached the regeneration stage four to five days before those who were kept in total darkness. Moreover, the difference in regeneration rate was first evident in the moderate early stage; it then increased during subsequent stages and the difference persisted during the observation period – observations similar to those in our study of *S. macrurus*.

"Today, the number of both terrestrial and aquatic species tested for their response to injury continuously grow, expanding the comparative analysis of regeneration capacities throughout the animal kingdom."

In 1983, a study by Young et al[8] also reported that restricted lighting conditions could retard regeneration in the adult salamander, Ambystoma. These two studies are not cited in the numerous papers dissecting the genetic and molecular factors of regeneration processes under controlled lab conditions. Whether or not changes in environmental lighting act through any of the currently known pathways or regulatory protein factors that activate or inhibit regeneration is currently unknown. Certainly, of more importance is whether or not the molecular switches and signalling pathways of current interest retain their predicted function in the mechanisms of tissue regeneration in less controlled environmental conditions.

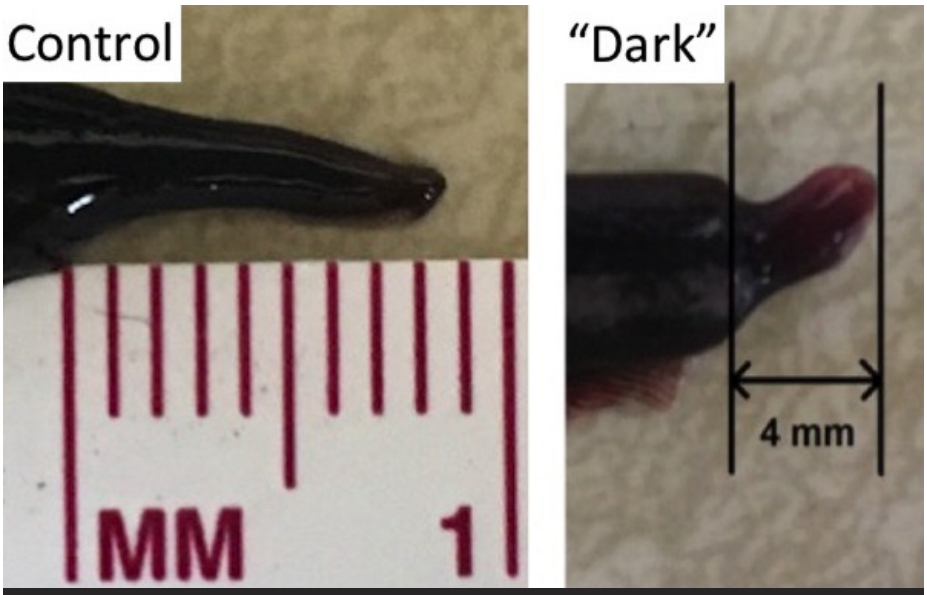

Figure 2: Light restriction leads to smaller regeneration blastemas. Images of partial S. macrurus tails 2 weeks after tail amputation under control and restricted light (i.e., "dark") conditions.

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Environmental Toxicology: How chemicals interact with environmental species and human physiology

The European Centre for Ecotoxicology and Toxicology of Chemicals (ECETOC) give a detailed perspective on environmental toxicology, a life science discipline that seeks to understand how chemicals, both natural and man-made, can interact with environmental species and human physiology to cause harm

Toxicology, a life science discipline, seeks to understand how chemicals, both natural and man-made can interact with environmental species and human physiology to cause harm. The art of toxicology has been known since the time of Socrates who was executed in 399BC using hemlock; a poison that acts slowly.

Toxicology as a science matured from this time with notable figures, such as Paracelsus and came of age after the thalidomide catastrophe of the early 1960s (human) and the discovery of the adverse effects of chemicals such as the insecticide DDT (environment). These adverse events directly led to the methods and supporting international legislation that now underpins the risk assessment of chemicals (in the widest context including drugs) on both human and environmental health. In counterbalance to chemical risk, it must be recognised that chemical use has brought substantial benefit to society.

Thus, in deciding whether to use a chemical, any identified risk has to be balanced against benefit in the context against which it is going to be used. This is called the risk/benefit ratio, with the aim being to make the ratio as small as possible. The least controversial risk/benefit ratios are achieved with chemicals used in therapy where the benefit of having a positive effect on the disease process usually outweighs toxicological risk by a substantial margin. For the use of chemicals in the natural environment this ratio can be more difficult and controversial (usually due to uncertainty discussed below) to compute. It is best addressed by ensuring that the risk part of the ratio is a small as possible, which leads to a need to have the best testing regimes that can be devised using current scientific knowledge.

To achieve this, the chemical industry, the EU and national governments dedicate significant resources to assess the potential environmental toxicity of chemicals.[1] EU legislative regimes relating to the manufacture and use of chemicals require comprehensive environmental toxicology assessments to be conducted for chemicals placed on the market.[2] This allows regulators (those responsible for assessing the risk), the chemical industry (responsible for providing the data from toxicology testing) and society (who derive and largely assess benefit) to achieve the maximum benefits from chemical use, at minimum risk. Ultimately, the most important part of these three is the end user, who makes the ultimate call on whether to use a chemical, relying on the expertise of the industry and the regulator in providing and assessing toxicological risk, respectively and of course, their own analysis of the benefit.

At this point, three common and important toxicological terms must be introduced, these are hazard, exposure and risk. Consider again for a moment, Socrates. At the time of his execution, he held in his hand a vial containing Hemlock. Hemlock affects the nervous system; thus, it is a hazardous poison, but it is contained within a vial and as such, it does not pose a risk. It becomes a risk when Socrates drinks it because at this point, exposure occurs. When there is both hazard and exposure, then there is risk. The risk increases with increased hazard and/or increased exposure with the

greatest risk occurring for a substance that has both a high hazard and high exposure. Those chemicals with the greatest hazard potential, usually interact very specifically with a critical part of a biological system. Those having the greatest exposure, are often those released without control into the environment. The absence of either hazard or exposure removes the risk.

Toxicology concerns itself with assessing and reducing the hazard, so risk management concentrates on reducing or eliminating exposure. Both are effective in reducing risk. A chemical in the environment is not hazardous if it has no interaction with any biological component of that environment and, thus, does not perturb the homeostasis (normal equilibrium) of the environment. Similarly, if a chemical is used but not released into the environment, it does not pose a risk (though risk management would include in this case, an assessment of accidental release). An environmental risk occurs only when a chemical has an adverse effect on the environment (hazard) and is released into that environment (exposure). Therefore, we can define risk as the product of exposure and hazard, which is the essence of toxicology.

We cannot quite stop there though. There are two further factors that need to be taken into account when assessing risk and these can be amongst the most challenging facing the environment and indeed human health, as well as the toxicologist. These factors are both time and uncertainty.

Let's deal with time first. It is fairly apparent that the longer a chemical is in an environment, the greater the probability and likely magnitude of exposure is. Once released into an environment, a chemical may start to degrade. This can be a slow or rapid process, or any time in between. Additionally, alterations of the chemical may take place in the environment from the actions of species in that environment, such as microorganisms. These processes may remove a chemical from an environment but can produce new forms that also have their own hazard properties that may be greater or less than the parent chemical. Therefore, part of the work of the environmental toxicologist is to assess what happens to a chemical in the environment, over what time frame and how this changes the risk. The time factor is, therefore, found in the majority of today's toxicological assessments.

Secondly, let's look at uncertainty. Arguably, this is the greatest challenge for the environmental toxicologist. No testing is perfect, no assessment of exposure is perfect. Both have uncertainties associated with them that can be due to measurement or biological uncertainty, often arising from an incomplete understanding of the

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exposed biological system. For this reason, testing methods and existing risk assessments need to be continually re-visited as scientific understanding advances to determine how new measurement technology or a greater understanding affects the assessment of risk.

For example, a notable current challenge in the field of environmental toxicology is the question as to whether current standardised test methods have greater uncertainties associated with them when used for new materials, such as chemicals in nano form (nanomaterials), microplastics and polymers. If the uncertainty of the testing method is too great for these new materials, then the data obtained is not fit for purpose. Similarly, there are questions about the appropriateness of current approaches in the field to assess the degradation of chemicals in the environment and, therefore, the time factor of the exposure assessment.

Risk is simple, it is the product of hazard and exposure. But, it is a big 'but', indeed, determining hazard and exposure can be challenging, as the above examples illustrate. Therefore, to ensure that the field of environmental toxicology continues to advance in practice, there is a need for a new generation of scientists who are well-trained in fundamentals and familiar with the most recent techniques and tools (in silico, in chemico, in vitro, in vivo). With enough people holding such fundamental training and experience, we can continue to improve our understanding of the impacts of chemicals on the environment and ensure that no unacceptable harm to the environment or to ourselves is caused by their use. Thus, we can continue to reap the benefit of chemicals with minimal risk. ■

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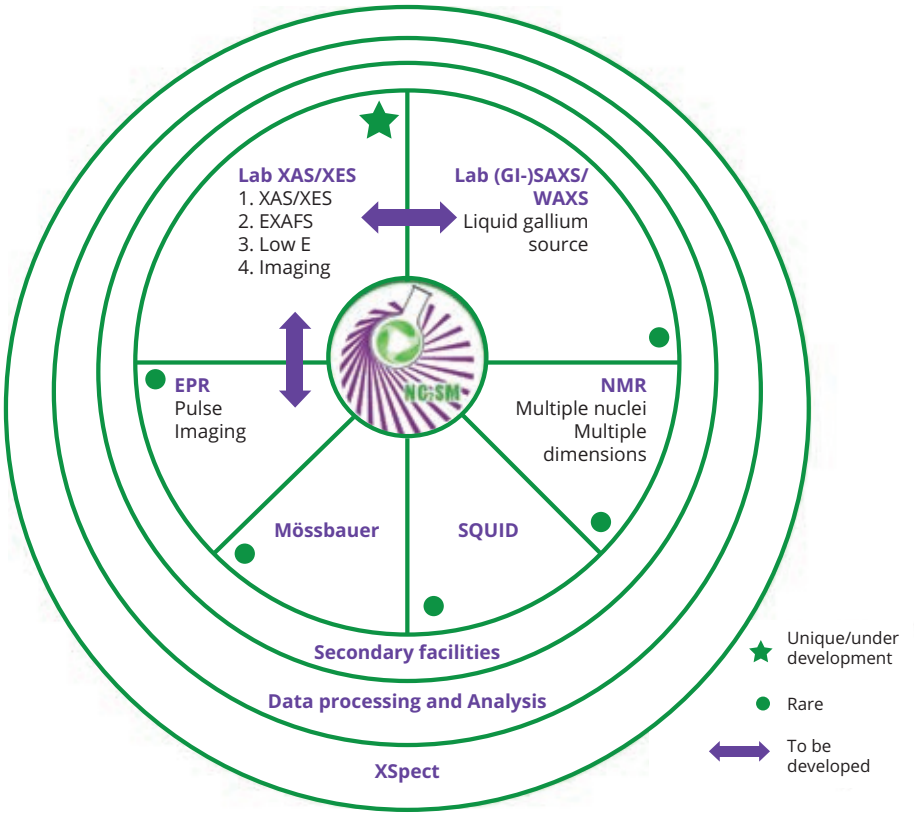
Understanding the characterisation of sustainable materials

Moniek Tromp, Van t Hoff Institute for Molecular Sciences, Sustainable Materials

Characterisation sheds light on sustainable materials and their benefits

An integrated expertise characterisation centre providing a full set of advanced characterisation methods, some of which unique to the world, will enable sustainable materials scientists to characterise their materials and processes in all detail; using all eyes and ears to make pictures and movies of molecules and materials in action. This allows the rational design of novel materials and processes, which meet today's societal challenges, i.e. clean, requiring limited energy and using cheap and abundant resources.



Overview of the facility, including embedding with full laboratory and computational facilities as well as data processing and analysis. Morever, a commercial service for data acquisition and analysis will be set-up (XSpect)

Important ace of sustainability

Sustainability is important to accommodate the growth of the world's population and its future demand of resources for water, food and energy at a higher average standard of life. This requires a significant change of today's practice, including the minimisation of the manufacturing footprint of a material, but also the sustainable gains of its use during the life cycle and clever reuse of the material or its components. Integral sustainability must become a driver for new energy technologies, to produce durable systems to convert, produce and store clean energy.

Resources for energy (fossil origin) and raw materials (rare elements) are depleting and this requires a transition to sustainable energy production as well as the reduction, replacement, or recycling of rare elements and the further development of bio-based materials. The transition to a sustainable society will likely have a tremendous impact. While initial efforts are aimed at reducing the footprint by making existing technologies more efficient, the final goal is a (circular) society based on truly sustainable resources for energy and materials. In this transition to a sustainable society, advanced materials will play a crucial role; a sustainable society cannot be realised without the corresponding materials that enable it. These materials will have in common: less non-renewable energy use and less greenhouse gas emission during the synthesis, construction, processing, packaging, transportation usage, recycling, and reuse.

Materials science

Materials Science is the discipline that engages with the design, synthesis, structure, dynamics and performance of materials. It is a multidisciplinary field that includes physics, chemistry, biology, and engineering, and studies materials in a broad range of length scales from the atomic scale, through

nano and micro, all the way up to the macro scale. In order to replace scare raw materials, the functionality of materials needs to be understood much better, i.e. at all levels and in all its details. Further development and increased availability of the characterisation toolbox for this is a prerequisite in this domain.

Proper understanding not only means characterisation of the geometrical structure, from atomic to molecule and agglomerate /particle scale, but also the electronic structure. The latter determines, for a large part, the properties and reactivity of materials, but is also typically difficult to pinpoint, requiring a multitude of different and non-standard characterisation techniques. A radically different approach towards materials characterisation is thus required.

Most laboratories active in a specific materials research area specialise and invest in one characterisation technique only, which is most important or best available to them, and have experts in that one technique only. The problem with most techniques is that they only provide partial characterisation of the material under investigation. Combining several measurements of the same sample, under identical conditions, often leads to much more information than just the sum of individual data. Current challenges in sustainable materials, as described above, require detailed characterisation on multiple levels which can only be achieved with multiple techniques, i.e. 'all the eyes and ears one can have'. Groups or laboratories generally do not have the possibilities (staff, finances and expertise) to offer, develop and/or execute all of these well. In addition to that, important X-ray techniques, allowing characterisation from atomic (Angstroms) up to inter-molecular information (micrometer) are typically performed at synchrotrons, with high oversubscription rates, severely limiting the accessibility. A radically different approach to materials characterisation is therefore crucial to ensure one can meet the materials science challenges we are facing today.

"Sustainability is important to accommodate the growth of the world's population and its future demand of resources for water, food and energy at a higher average standard of life."

National Characterisation Centre for Sustainable Materials

To unravel the novel chemistry displayed by these feedstocks and materials as well as their differing reactivity requires multiple advanced techniques, in an integrated approach. We are therefore in the process of setting up a National Characterisation Centre for Sustainable Materials (NC2SM) in which we bring important non-standard techniques together in one place, as well as develop novel and combined ones, by making x-ray absorption, emission, and scattering techniques available in the laboratory. Having access to all techniques in one place, thus making it possible to collect all necessary data in an unequivocal manner on the same sample under identical (operando) conditions, is key to fundamental materials understanding and subsequent rational design and development.

The suite of techniques will give detailed structural as well as electronic information on the broad range of materials, at different time and length scales, from all different parts of the material/molecule. All techniques have their individual strengths and limitations, and only a combination of all can provide a full picture and movie of the sample and its reactivity. Moreover, the integrated centre will therefore not just act as a place to obtain data, but also as a sounding board and discussion platform for materials scientists, spectroscopists and theoreticians, which will catalyse novel and exciting science and advances in all fields.

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Pesticides: A contributing factor to the increase in asthma?

Pamela J. Lein at the University of California, Davis discusses the evidence suggesting that pesticides are risk factors for asthma

Asthma is a chronic inflammatory lung disease, characterised by episodic and reversible bronchoconstriction (contraction of the smooth muscles that line the airways), excessive secretion of mucus in the airways and airway hyperreactivity (an exaggerated reaction of airway smooth muscle to contractile stimuli). All of these effects interfere with breathing.

Worldwide asthma prevalence and severity has increased markedly over the past two decades, especially in urban settings. Many hypotheses have been proposed to explain the increased asthma in urban residents, including exposure to allergens, air pollution, differences in healthcare and stress. However, an environmental factor associated with agricultural asthma that is beginning to receive increased attention in the context of urban asthma is exposure to organophosphorus pesticides (OPs).

OPs are the most widely used class of pesticides worldwide and are applied extensively in not only agricultural but also in suburban and urban settings to control insects. Although residential uses of OPs are being phased out in the United States and many European countries, OPs are still used heavily in agricultural, industrial and commercial settings and OPs are widely detected in the general human population in all countries in which this has been assessed.

Occupational exposures associated with the production, distribution and application of OPs occur primarily via dermal absorption, with more limited exposure via inhalation. The general population is exposed to OPs via ingestion of food and water contaminated with OPs and by dermal and inhalational exposure to pesticide drift and "overspray". The latter is not an insignificant source of exposure as extensive OP contamination has been documented in the air, homes and urine from pregnant women and children living in communities near agricultural fields sprayed with OPs

OPs inhibit the enzyme acetylcholinesterase, which functions to inactivate the neurotransmitter acetylcholine. Acetylcholinesterase inhibition significantly increases acetylcholine levels at the synaptic junction between nerves that secrete acetylcholine and their target tissues, causing excessive stimulation of target tissues.

Acetylcholinesterase activity is functionally important in not only insects, but also humans. It is well established that OPs cause neurotoxicity in humans by inhibiting this enzyme, a medical condition referred to as the cholinergic crisis. Acute exposures to OPs that inhibit acetylcholinesterase by more than 80-90% of control levels can cause death in humans, typically by inhibiting the respiratory centres in the brain that control breathing. Thus, many regulatory agencies have identified safe levels of OPs as those that do not inhibit acetylcholinesterase.

Case reports published in the 1960's provided the first indication that exposures to OPs at levels that do not cause cholinergic crisis may trigger asthma in adults. Subsequent cross-sectional studies of farmers and their families, farmworkers and commercial pesticide applicators in multiple countries around the world provided further evidence that occupational exposures to OP pesticides are associated with adult-onset asthma.

More recent epidemiologic data suggest that not only occupational exposures, but also exposures to environmentally relevant levels of OPs, such as might be experienced by the general public, are associated with increased risk of asthma and asthmatic symptoms in adults and adolescents. OP-induced asthma may not be limited to these age groups, as indicated by emerging data from the Center for the Health Assessment of Mothers and Children of Salinas (CHAMACOS), the longest-running longitudinal birth cohort study of pesticide effects on children's health, which has been studying children in a farmworker community in the Salinas Valley of northern California. Data from the CHAMACOS study suggests that OP exposures during pregnancy and the first year of life, as determined by analysis of urinary OP metabolites in pregnant women and their infants,

Farm worker spraying pesticide treatment on fruit garden

are associated with respiratory symptoms in children at five and seven years of age.

While systematic reviews of the published epidemiologic literature generally support an association between OP pesticide exposure and asthma, it is difficult to establish a cause-effect relationship based on human data. This is due in large part to the fact that it is extremely challenging to accurately quantify OP exposure in humans. Thus, studies in animal models are critical for determining whether OPs are causally linked to asthma. The animal studies published to date support the hypothesis that OPs directly cause airway hyperreactivity, a key symptom of asthma.

Importantly, OP-induced airway hyperreactivity is observed at levels that do not inhibit acetylcholinesterase. Several different OPs, including chlorpyrifos, parathion and diazinon, can induce airway hyperreactivity in guinea pigs following subcutaneous injection, a route of exposure that mimics dermal exposure in humans. In contrast, pyrethroids, a class of pesticides structurally and mechanistically distinct from OPs, do not induce airway hyperreactivity in guinea pigs, suggesting that the airway response to OPs is not a generalised property of all pesticides.

Interestingly, the effect of OPs on airway hyperreactivity was not evident immediately after exposure, but rather were manifest 24 hours later and persisted for at least seven days after a single injection of the OP. Further studies in the guinea pig model suggest that OPs cause airway hyperreactivity by interfering with neural mechanisms that normally function to limit the release of acetylcholine from airway nerves onto airway smooth muscle. This effectively increases the amount of acetylcholine available to cause contraction of the airway smooth muscle.

How OPs cause dysfunction of airway nerves remains an outstanding question, although preliminary data suggest that the mechanism may vary depending on the allergic status of the individual. Answering this question will be critical for identifying susceptible subpopulations and for designing more effective therapeutic interventions for preventing or reversing OP-induced airway hyperreactivity. More immediately, these findings raise significant questions regarding the use of acetylcholinesterase activity as a point of departure for regulatory action. Furthermore, these findings suggest the possibility that the increased prevalence of asthma is related less to the insects that we live with than to the chemicals we use to kill them.

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Endocrine disrupting chemicals: The issue of mixtures toxicity assessment

Alberto Mantovani from Istituto Superiore di Sanità, Roma – Italy sheds light on endocrine disrupting chemicals (EDC), including discussion of mixtures toxicity assessment

One strange side of toxicological risk assessment is that this science aims at characterising the hazardous properties of single substances, in order to provide the scientific bases for regulations and controls in food, the environments and products.

Yet, everybody knows (even toxicologists) that, with the exception of many workplace settings, we are rarely exposed to one chemical at a time. In their everyday life, mankind experience exposure to a number of hazardous chemicals, albeit each one is usually encountered at very low amounts.

In some cases, single items bring with them a mixed exposure. Let's look in particular at such a hot topic as endocrine disrupting chemicals (EDC). One example is fatty fishes, especially the large ones; these animals are likely to contain in their flesh a mixture of persistent, fat-soluble pollutants, such as dioxins, polychlorinated biphenyls and polybrominated flame retardants. Indeed, dioxins and similar compounds are considered to act in a similar and additive way (each chemical contributes to the toxic effect according to its potency and amount); accordingly, the contamination by dioxins and a dioxin-like substance is monitored altogether as a mixture. But the other fat-soluble pollutants are still controlled without approaching the possible mixture effects. However, all these persistent pollutants are EDC, affecting steroid or thyroid homeostasis; thus, a combined effect should not be ruled out.

Another example is multiple residues of pesticides: indeed, the European monitoring plans (assessed by the European Food Safety Authority, EFSA) show that each year over 20% of fruit and vegetable samples contain residues of multiple pesticides (even more than five), each one being below the legal maximum residue level. So, how do you assess them? Can they pose a risk to consumers? Although the European Commission has still to take a legislative decision on this, since 2013, EFSA has proposed a science-based approach: pesticide residues are expected to act in an additive way (to sum-up their toxicities) if they share the same target and effects, even though molecular mechanisms and chemical structures may be different. EFSA made an EDC-relevant example: over 100 pesticides inhibit thyroid function in rodent toxicological assays. The mechanisms can be different (interference with hormone synthesis, increased hormone catabolism, etc.) but all share one endpoint, hypothyroidism; therefore, these chemicals should be considered as able to sum-up their hazardous effects.

EU policies have been successful in limiting pollution and adverse effects from single substances and single exposure routes. However, to overlook the challenge of assessing mixtures means an ineffective appraisal of chemical pressures that might affect human and environmental health; this is supported by several human biomonitoring data showing that the general population may bring a considerable number of man-made chemicals in their bodies. Actually, the current EU regulations lack a systematic and integrated assessment of mixture effects.

So, how to tackle toxic cocktails?

First of all, there is a need to identify the actual mixture exposures that are more relevant to human safety: these may include exposures during fetal development and through air, food and consumer products. Life stages may experience different exposures: for instance, small kids may have higher exposures from contaminants from indoor dust, including EDC, such as brominated flame retardants and phthalates. The major challenge is the comprehensive exposure assessment across multiple sources and pathways in

different population subgroups, as it has been attempted by EFSA for one individual EDC, bisphenol A in 2015. This challenge is highly time- and resource-consuming, even for single substances; thus, it should be carried out on high-priority mixture issues.

Then, we need to know better how a cocktail works. Current toxicological risk assessment is often exposure-driven, indeed, this may work, provided that we remind ourselves that the ultimate goal is to assess the likelihood of adverse effects; thus, adverse effects have to be characterised. Effects could also be used for exposure evaluation, like toxicity fingerprints (effects on nuclear receptors or biosynthesis enzymes in the case of EDC) that can help to prioritise contaminant mixtures and monitor options for pollution abatement in environmental media.

"Although the European Commission has still to take a legislative decision, since 2013 the European Food Safety Authority, EFSA has proposed a science-based approach: pesticide residues are expected to act in an additive way (to sum-up their toxicities) if they share the same target and effects, even though molecular mechanisms and chemical structures may be different."

But the above actions may just remain a nice academic exercise, in the absence of mandates for performing mixture risk assessments by policymakers. The requirements for taking mixture toxicity into account have been partly established under a few pieces of EU chemicals legislation, including the plant protection product regulation: however, as mentioned above, the practical regulatory application of this legislative principle is still lagging behind. Significant progress is not achievable without the driving force of requests and provisions from the side of policymakers.

The main policy provision should be the request for a consistent approach, meaning that there should be uniform principles for performing mixture risk assessments across regulatory fields: food additives, pesticides, textiles, waste management, etc. Fit-for-purpose mixture assessment also implies the definition of regulatory acceptable levels for mixture risks: such rules are largely missing. Without such rules, inconsistent assessments may result, in particular, due to different ways of accounting for uncertainties.

Unfortunately, the current approaches for establishing, for example, tolerable daily intakes for single contaminants are not readily transformable into the corresponding rules for mixtures. In the meanwhile, we cannot wait until a "perfect model" is finally ready to address mixtures risk assessment and regulation. Rather, we can start to act here and now by making the best possible use of some approaches that already exist and can be transferred from more data-rich chemicals (e.g., pesticides) to data-poor chemicals (for example, land waste by-products. This must not deter research toward approaches that are more refined and less burdened by uncertainties. For instance, the effect-driven approach on multiple pesticide residues elaborated by EFSA is workable here and now, but its uncertainties can be reduced considering also the use of adverse outcome pathways networks (already discussed in a previous profile): these can bring about a considerable improvement by refining the scientific criteria for grouping together different substances.

Finally, in all fields, but especially in the highly critical and still developing field of chemical mixture assessment, the translation of research and knowledge into evidence-informed policies requires knowledge exchange and dialogue, in a way that gains and keeps the trust of the public. ■

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Chemistry in the UK today

Open Access Government explores the exciting world of chemistry in the UK today, including heterocycles in pharmaceuticals and the importance of inspiring the next generation to work in the field

The Royal Society of Chemistry in the UK is geared towards promoting, supporting and celebrating chemistry, plus advancing excellence in the chemical sciences. Among the organisation's many noble aims, is advising governments on policy, as well as promoting talent in the field and ideas that lead to tremendous advances in science.

In the view of the Royal Society of Chemistry, chemistry and the chemical sciences are crucial in our changing and complex world. Indeed, they are vital in our everyday lives and also in helping the world respond to some of its greatest challenges. In this vein, we find out that the chemical sciences community is working to develop innovative technologies, such as new antibiotics, batteries and solar cells or water purification membranes and drought-resistant crops.[1]

One aspect that the organisation is keen to promote concerns supporting and celebrating inclusion and diversity in the field of chemistry. Certainly, chemistry should be for everyone and increasing diversity in the field is a priority for the Royal Society of Chemistry. On their website, they remark that obstacles to studying and undertaking careers in the field remain. Their 2018 report brings together some of the available evidence about the current state of diversity in the chemical sciences, focussing on the UK.[2]

The report highlights areas of progress, but it also reveals just how far we have yet to go. Also, in this report, the Royal Society of Chemistry look at diversity and inclusion from three principle perspectives: students in higher education; staffing and careers in higher education; and diversity in scientific research.[3]

The Royal Society of Chemistry understands that the success of the chemistry community depends on their ability to nurture the talent of the best people, regardless of who they are or their background. As such, the organisation is working to shape the future of the chemical sciences, to benefit science and humanity.

Heterocyclic Chemistry

In a previous article in Open Access Government, we learn about one area of chemistry that certainly benefits humanity. In this article, Professor of Organic Chemistry at the University of York and Chairman of the Royal Society of Chemistry's Heterocyclic and Synthesis Group, Peter O'Brien explores the role of heterocycles in the pharmaceutical industry.

In this article, he explains that in 2017, the Royal Society of Chemistry's Heterocyclic and Synthesis Group celebrated its 50th anniversary. It is, therefore, apt that he highlights that heterocycles have played an important role in pharmaceutical drugs during the last 50 years. He explains more on this fascinating point in his own words.

"Heterocycles are literally everywhere – from the caffeine in a cup of coffee to the building blocks of DNA – and nearly all marketed blockbuster pharmaceutical drugs contain at least one heterocycle."

An interesting aspect of the article concerns exactly why are heterocycles so common in pharmaceuticals? This is something he keenly explains, in his own words.

"Pharmaceutical drugs generally work by interacting with a binding site in a protein. Common types of interactions include electrostatic, hydrophobic and hydrogen bonding. Heterocycles containing nitrogen, oxygen or sulphur atoms, whether heteroaromatic or not, offer excellent opportunities for hydrogen binding interactions with the functional groups in proteins. However, as well as providing protein binding groups, heterocycles also affect the solubility of drugs and their metabolism profile."[4]

Inspiring the next generation – shaping the future

We mentioned earlier that one of the aims of the Royal Society of Chemistry is to shape the future of chemistry, so in this vein, inspiring budding scientists is an important aspect of their work. In June this year, two members of the RSC Essex Local Section visited a local primary school and had some exciting demonstrations.

These demonstrations included a school assembly on gases with the volcano experiment, using baking powder and vinegar. Most of the audience was surprised by the reaction, plus the addition of food colouring ensured a very spectacular and large display of red froth. Another demonstration involved liquids and the red cabbage indicator, which included unwrapping and shredding for everybody to view, which certainly increased the level of tension. The greatest element of surprise during the day arrived when they added vinegar and the colour changed from blue to red in an instant. Other colours were viewed with bleach, cola and lemon juice, we are told.

After the event, the Royal Society of Chemistry ponders just how many of these children will become future Royal Society of Chemistry members, and hope that the memories of them in their white lab coats will go far in influencing their decision.[5] ■

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The challenge of commercialisation: Keeping an academic balance

Prof Colin J Suckling OBE DSc FRSE, research professor of chemistry at the University of Strathclyde's Department of Pure & Applied Chemistry shares his views on the challenge of commercialisation when it comes to research into medicinal chemistry

Over the past 20 years especially, there has been a cultural transformation in most British universities from a more or less collegiate academic organisation, to in differing degrees and overt commercial structure. Interest in the commercial exploitation of academic research has always been important to my university, the University of Strathclyde in Glasgow. Indeed, its founder, John Anderson in 1796 specified that it should be 'a place of useful learning' and 'for the benefit of mankind'. Today, the University of Strathclyde can point to having formed over 50 spin-out companies, making annual sales of £80 million and continues efforts to expand its impact through business development of its research output.

In connection with my own research in medicinal chemistry, I have been engaged in commercialisation activities since the mid-1980s. The royalties from these commercial activities have funded new academic posts and facilities and also made possible further research supporting our partner companies and developing new opportunities. In this way, a virtuous cycle has been completed coupling curiosity-driven research with genuinely potential commercial outcomes.

An inevitable question then arises as to how best to couple the traditional role of academic research with wealth creation, supported significantly by public funding of the British universities. Last year, I published an e-book entitled 'Blue sky research, is it worth it?' which attracted some attention in the business community. This short e-book demonstrated how much of my own research in medicinal chemistry, depended upon major discoveries in chemistry, physics, and biology as exemplified by Nobel Prize winners of the last 50 years. Simply put, if it had not been for these blue skies discoveries and many others that were not recognised in this way, I could not do what I do now. That said, in tune with John Anderson's requirements, I have always had an interest in the commercialisation of research as a scientist and an academic manager.

The cultural transformation in universities notwithstanding the challenge for academic science remains to generate new knowledge in such a way that there is a clear track for translation into the commercial domain. For my own field of medicinal chemistry, there is a happy combination of research philosophy, experimental work and potential commercial outcomes through the contiguous scientific field known as chemical biology.

Chemical biology is defined in Wikipedia as chemistry applied to biology and in doing so, allows scientists to understand better how biological systems work, in particular, in their interactions with small molecules that are typical of drugs. So, a programme of research involving blue sky chemical biology with commercialisable medicinal chemistry matches the modern requirements for research strategy beautifully. Not only does this approach make new things possible, it also makes them understandable, both of which are important. The remaining component of research strategy is to select projects that at the start would not be attractive to industry perhaps because of the novelty of approach or the perceived risk. The latter will be mitigated as the research progresses through the research outcomes. In my own recent work, two projects stand out as examples of this approach.

> "I am convinced that the partnership of medicinal chemistry and chemical biology is the best way for an academic chemistry laboratory to make a strong contribution to human and animal health. Not only does it generate new knowledge and opportunity, but it also starts the translation into drugs 'for the benefit of mankind', as the founder of the University of Strathclyde put it."

Antimicrobial resistance (AMR) is a global problem. In the more affluent countries, most people think of it in terms of bacteria, colloquially called superbugs. The scope of AMR is much wider, however. Drug-resistant fungi are widespread and parasitic diseases,

Prof Colin J Suckling OBE DSc FRSE

including malaria, still present serious risks to human health in tropical and subtropical regions. Moreover, animal health is challenged especially in sub-Saharan Africa and South America by trypanosomes, the parasites that cause sleeping sickness.

Our programme, using minor groove binders for DNA as drugs, was conceived to have a wide impact because the mechanism of action allows us to target all of the above infectious agents. Indeed, we have discovered different compounds with commercialisable activity against all of them. And there lies one of the commercialisation challenges. Because each indication relates essentially to a different market, we require different commercial partners to develop each active compound. We're doing the best we can to deal with the commercial reality and the most advanced compound, an antibacterial drug, has reached a phase 2 clinical trial through the efforts of our partner company, MGB Biopharma.

Turning to the second field, it is normal in the pharmaceutical industry to identify single compounds for the treatment of single diseases through a well-defined biological mechanism. Scientifically, this is an entirely valid and rigorous approach that lends itself to quantitative evaluation for commercial decisions. Because it is so tightly drawn, however, this approach risks missing real opportunities.

Our work in discovering new immunomodulatory compounds is an example of a project that has a different trajectory from the industry norm. We designed some small molecules based upon the properties of a protein secreted by a rodent parasite and came up with a group of compounds able to treat diseases such as asthma, rheumatoid arthritis, lupus, and lung fibrosis, all of which have been demonstrated in animal models of each disease.

But having such effective compounds sets up a commercialisation conundrum; this situation is not at all normal. What disease are we to treat? How do these potential drugs work? Well, chemical biology has come to the rescue with respect to the second question and through a collaboration with scientists at the U.S. Army Research Laboratory (ARL), we now have some good ideas about a mechanism of action. The question of diseases to treat, however, is not simply scientific; it requires consideration of unmet need, potential competition, and the marketplace. We're discussing these things now with interested companies.

In the end, commercialisation is not in the scientist's hands; others take over the lead and the decision making. Nevertheless, I am convinced that the partnership of medicinal chemistry and chemical biology is the best way for an academic chemistry laboratory to make a strong contribution to human and animal health. Not only does it generate new knowledge and opportunity, but it also starts the translation into drugs 'for the benefit of mankind', as the founder of the University of Strathclyde put it.

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Blockchain in the European Union: How the European Parliament approaches DLTs

Eva Kaili, MEP, Rapporteur of the European Parliament of the Blockchain Resolution, explains her thoughts on blockchain technology in the European Union today

On the 16th of May 2018, the Committee of Industry, Technology, Research and Energy of the European Parliament, voted with the complete support of the all the parties, with the impressive majority 56 in favour and one against, the Resolution on DLTs and Blockchain, that I introduced as rapporteur.

It was not only one of the very few times that all the political parties unanimously supported a text, it is also a strong message that the European Parliament sent by defining the optimal way of how to approach blockchain technology, how to allow it to scale-up and how to enable it to give practical solutions to the everyday lives of the consumers and citizens.

It is true, that it is difficult to identify the best way to approach a technology which is still evolving and has an uncertain impact.

It is, therefore, necessary, to identify regulatory principles. I suggested that it is of main importance, not to violate or delay with a defensive approach, the innovative and disruptive character of the technology. For this reason, I believe that the two instrumental principles we should use are the technology and business model neutrality principle.

Technology neutrality principle means that we should not regulate the technology per se, but its uses and those who use it. In this way, we provide the emerging blockchain and distributed ledger applications with legal certainty and a strong layer of consumer protection. On the other hand, the business model neutrality principle has a market structure dimension. The regulator makes sure that it will not intervene in favour of any business model, legacy or emerging and will allow the market to decide freely. Practically, this means that if blockchain can positively disrupt existing value chains and distort legacy business models and actors, then let it do so.

In my view, it is important for both citizens and policymakers to see the potential of blockchain beyond cryptocurrencies. The resolution of the European Parliament was a tool to raise awareness between the policymakers and citizens, in that blockchain is not just Bitcoin. Bitcoin is a great example of decentralisation and an even more revolutionary peer to peer exchange of value than the peer to peer exchange of files and information, like BitTorrent does.

> "Of course, a very important part of this resolution underscores the potential for innovative start-ups and the Small and Medium Enterprises (SMEs). Blockchain has a strong market structure impact that reduces the entry costs of SMEs and start-ups in markets, augments competitiveness and boosts the redistributive forces of the market."

In the first part of the text we describe the different "families" of DLTs, permissioned and permissionless and we provide indicative examples of sectors that could be affected, including energy, supply chains, the financial sector, healthcare, education, the creative industries, transportation and even the public sector with ID blockchain solutions, for example. In our approach, blockchain is not just a technology. It is an infrastructure that can allow us to build upon innovative solutions, like the Internet of Things (IoT), AI and more emerging technologies.

Blockchain is also an enabling technology. To boost its potential, we must make sure that there is open fertile ground around it. One of the major priorities of this resolution is to define the requirements of a vibrant ecosystem. Building a competitive blockchain ecosys-

tem also requires addressing some major challenges. In our resolution, we touch fundamental issues like the interoperability, scalability, standardisation, cybersecurity, and data privacy that solutions need to be further explored.

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Smart contracts are also welcome in this context and we underline the need for legal certainty as soon as possible, while the European Blockchain Observatory will map not just blockchain applications, but also the best practices to provide guidelines for a harmonised regulatory environment and as several Ethereum applications could achieve.

Of course, a very important part of this resolution underscores the potential for innovative start-ups and the Small and Medium Enterprises (SMEs). Blockchain has a strong market structure impact that reduces the entry costs of SMEs and start-ups in markets, augments competitiveness and boosts the redistributive forces of the market.

SMEs and start-ups also are benefited by the tokenized crowdfunding that ICOs can provide. Our report stresses the potential of ICOs in accelerating technology transfer by improving the allocation of capital to unbankable projects and to some extent, correcting the poor performance of the VC markets. It is of high concern, though, the potential of fraud and the lack of legal certainty around ICOs.

Different jurisdictions adopted different regulatory approaches. For example, the US put ICOs under the umbrella of securities, whereas Korea banned them altogether. What we propose in our resolution, is to consider the options beyond the apparent regulatory solutions. It is not necessarily new financial instruments to fit in old boxes. ICOs might be a distinct,

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brand new asset class. One of the proposals of our resolution is for the EU to establish an ICOs and Tokens Observatory to explore legal needs, best practices and bad practices as well.

Finally, in the area of cryptocurrencies, it is of paramount importance to open our mind beyond the considerations of the traditional monetary theory. We need new monetary policy models to stay relevant. In our resolution, we stress the need the European Central Bank (ECB) to abandon its defensive position and explore tools that reduce the volatility of cryptocurrencies. We understand, of course, that given the current volatility, cryptocurrencies cannot function as "store of value". But they probably are not commodities as well.

A few months ago, the European Parliament stressed in the Anti Money Laundering Directive that cryptocurrencies are not just means of exchange but means of payment. This has significant tax and payment tracking implications. At the same time, cryptocurrencies should be adopted in the Euro-area payment system because, contrary to a simple digital-currency, a cryptocurrency can be programmed with smart contracts and unleash a wide range of economic opportunities. I see very positively the case to explore a Euro-cryptocoin, an open decentralised Euro Exchange and more tools to make the most out of this technology.

I believe that with this approach, the message that the European Parliament sent was very productive, unbiased and promising. My view, and most importantly the European Parliament's view, is that Europe can be the leader of the Second Machine Age and lead in the era of blockchain and artificial intelligence (AI), just like the US was the global leader in the era of the internet. More exciting blockchains are on the way, while more legislation is also on the way and it is Europe that could be innovation-friendly and give trust and control of their data, back to the citizens. In the meantime, we already work for open data for the public good, since this would be the fuel of the future and science. Blockchain could play an important role to give transparency in the use of our data for science, to know who when where and why is using it. GDPR was just an example of what we can achieve to protect privacy and lead globally.

"Blockchain is also an enabling technology. To boost its potential, we must make sure that there is open fertile ground around it. One of the major priorities of this resolution is to define the requirements of a vibrant ecosystem. Building a competitive blockchain ecosystem also requires addressing some major challenges. In our resolution, we touch fundamental issues like the interoperability, scalability, standardisation, cybersecurity, and data privacy that solutions need to be further explored."

We continue our systematic, open-minded and careful work and we hope soon to see the first results of our policy in the quality of services that Europeans receive both as consumers and as citizens. ■

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The core principles of smart contracts

Frederik De Breuck, Presales Director and Business Assurance BeLux, Head of the EMEIA Blockchain Innovation Center at Fujitsu Technology Solutions reveals his thoughts on the core principles of smart contracts

Smart contracts are now becoming a key discussion topic. Although Nick Szabo conceived the concept of smart contracts over 20 years ago, at the time there was no practical way to realise them on a relevant commercial scale. The key business value of smart contracts is the capability to automate many kinds of processes and operations.

Obvious examples are transactions and events that require initial payments between parties, however, this is only one of many smart contracts use cases. As Nick Szabo puts it: "the fundamental logic is the automation of 'if-this-then-that' on a self-executing basis with finality".

The core principles

At its core, a smart contract is an agreement, in a different structure, between two or more parties stored on each node in a distributed ledger network. It is important to note that the term 'contract' can be misleading as, to date, it is not (yet) a contract in the true legal sense of the word, often leading to some confusion (for example, as promulgated in the 'code is law' – discussion).

Within distributed ledgers, smart contracts are coded instructions (typically event-driven; machine-readable) on ledger (blockchain) computers (nodes) which execute the specific terms and conditions that exist in contracts between parties. Specifically, they embed an agreed business logic in code.

Typically, these parties will be individuals, corporations, governmental agencies or other juristic entities with a legal identity, however, multiple parties who may not trust each other fully could be envisaged.

Capturing contractual trust relationships in a classic 'if-then-else' construction to maintain the representational veracity of terms and conditions, however, is radically different. Automated instruction processing exists today (for example, bank accounts), but this is not controlled by multiple nodes/participants in a network. In most architectures, these smart contracts operate without any specified trusted organisation, central authority or server.

It is possible to create highly sophisticated code which has greater autonomy and self-management, enabling further smart contract functional automation. Emerging use cases and developments with autonomous parties may drive the expansion of the DAO (Decentralized Autonomous Organization) connecting IoT (The Internet of Things) devices, which execute smart contracts without human intervention.

Transformational

A smart contract can be transformational, due to automation of business processes in a trust relationship. This can occur by permitting all stakeholders to process and validate contractual rules as a group via an agreed and predefined consensus mechanism or application logic.

The differentiating characteristics of smart contracts in the context of distributed ledgers are:

- They represent contractual trust relationships in computer code (machine-readable), based on predefined logic;
- They are using a distributed ledger architecture, participating nodes running logic in parallel and then committing changes;
- They are – at least in theory – self-verifying and self-executing, with a higher degree of resistance to tampering;
- They can transform legal obligations into an automated workflow;
- They reduce the transaction cost;
- They limit the need for trusted intermediaries;
- The reconciliation of the smart contract comes before data/result is stored, rather than after, ('confirm as you go' versus 'confirm after the fact');
- There is no single source of control of the smart contract;
- They increase flexibility and transparency and;
- The outcomes are far more deterministic than natural language contracts bringing new elements to

solve, (for example, trying to express 'on-purpose' or 'having the intention' in computer code is not straightforward).

So how does it work in practice? Assets (or tokenized assets) and relevant contract terms are coded and put into the distributed ledger network. This contract is distributed and instantiated on each participating node in the network. After an event (transaction) triggers the contract, the contract is executed in accordance with the defined contract terms embedded in the smart contract file.

The code checks the execution of the commitments automatically and produces a non-reputable transaction. On platforms such as Hyperledger Fabric, smart contracts are implemented by a construct known as Chaincode.

The outcomes may be controversial since, as previously stated, they are more deterministic than natural language contracts, triggering the need for human arbitration. It may prove impractical to engineer all possible answers to all contractual variations and outcomes. Additionally, courts will not enforce otherwise valid contracts unless compliant to the fundamental legal principles regulating the economic fabric (for example, contracts can never remove obligations set by law, or case law, such as Donoghue V Stevenson)

AI to the rescue

AI can deliver additional value to this workflow. This would also facilitate a completely new debate: self-adjusting contracts and workflows. Smart contracts can prove inflexible, unable to adapt to changing circumstances or may need revision as the economic fabric changes.

AI can prepare, manage and automatically enforce elements of smart contracts. However, in its current developmental state, it is unlikely that AI could create and manage smart contract code updates and releases covering such principles as intention, fairness, ability to be reasonable, efficiency growth, etc.

Some examples

Clearly, all possibilities must be examined. The most promising areas for deployment are:

- **Self-sovereign digital identity:** Allows individuals to control and master their personal digital data and (tokenized) assets. The selective disclosure can be managed via smart contracts;

- **Data recording (financial and other):** Entities can utilise smart contracts to automate and simplify data recording and tracing allowing for more transparent reporting and automation of audit trails.

- **Contract automation:** Specific contract or outcomes can be codified to allow two or more parties to automate contractual agreements in a trusted way.

- **Tracking in supply chains:** By using tags/immutable IDs on supplies and/or materials and adding them to the ledger, combined with smart contracts, can ensure the validity of the captured information and certify its authenticity (fraud detection, end-user safety, chain of custody, etc.)

So, what now?

The above examples only the beginning. Clearly, smart contracts are not a panacea. (nor is distributed ledger technology). There is still significant work to be done especially in the area of matching standard natural language contracts with pure code contracts (and Hybrid).

Ensuring that domestic and international legal and compliance frameworks are ready to enable adoption in business models and processes and the interaction between smart contracts and classic contracts (for example, arbitration), are currently the largest impediment today.

Smart contracts have the potential to reduce operational risk in contracts with multiple participants. The importance of business readiness for this change cannot be overstated.

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The transformative nature that blockchain could have on the public sector

Jonny Voon, Innovation Lead – IoT & Distributed Ledger at Innovate UK shares a compelling perspective on the transformative nature that blockchain could have on the public sector

Blockchain has been described as the best thing invented since the Internet, with the term now firmly at its peak on everyone's hype radar. While the majority of the noise around blockchain tends to be finance-related (fintech and cryptocurrencies), this shouldn't detract from the transformative nature blockchain could have on the public sector.

Do we need to use blockchain for everything? Absolutely not. The key challenges for public sector lie in identifying valid uses for blockchain technology that meets the needs of the organisation, provides minimal disruption to everyday processes and is technologically sound.

What exactly is blockchain? Put simply, a shared and decentralised database that has data mutually agreed upon through consensus. One application of this is blockchain, where a time-stamped and integrity-checked record is added sequentially and linked to previous transactions. See here, and here for more in-depth and technical definitions.

If it sounds a lot like a distributed ledger, that's because it is. The power of blockchain lies in its immutability and resilience. Although there are private and permissioned (or consortium) blockchains that are owned and access-controlled, the majority of blockchains are public which means anyone can take part in mining, creating a transaction and storing a copy of the ledger.

You might have heard a lot about cryptocurrencies (like Bitcoin, Ethereum and Ripple to name but a tiny fraction) in the past few years and wondered what they had to do with blockchain. They are just as integral a part of blockchain as the ledger itself.

So how do you know if a blockchain is right for you? Consider the process of verification of a document – perhaps an ID, benefits authorisation or ownership of a car – and the frequent need for someone to have to have sight of a physical version in order to validate its authenticity. Now imagine if these documents are certified authentic by its issuer and its validity put on to a blockchain. Now – when opening a bank account, moving to a new city or selling a vehicle – a bank, local authority or buyer can simply query the blockchain without having to physically see (and often store) personal data. As the ledger is timestamped, any revocation by a validation authority would instantly supersede previous authorisations.

Jonny Voon, Innovation Lead – IoT & Distributed Ledger at Innovate UK

Blockchain has the ability to be absolutely disruptive to almost every industry in our economy as we're heavily reliant on the sharing of personal information between organisations.

Even in the public sector, we're not immune to the potential impact of blockchain and some would argue (including myself) that that is where the biggest transformation could take place. If we look at how closely entwined data in the public system is – from NHS records, council tax and social care systems, welfare and benefits, education, taxation, identity, vehicle and home ownership – we are followed by a paper trail all the way from birth certificate to death certificate!

Many more examples were raised in a recent report by Lord Holmes of Richmond, which pulled together experts to highlight some of the many challenges and opportunities for blockchain in the public sector. This followed on from a report by Sir Mark Walport (UK Government's Chief Scientific Advisor and CEO of UK Research and Innovation) and the Government Office for Science, published in 2015.

So, what should the public sector be doing when it comes to blockchain? We need active deployments of all sizes and shapes to understand the implications (economic, process, etc) of the technology. That requires public sector bodies to step forward and work with industry to refine appropriate challenge areas that may not always be feasible in the short-term.

Is the technology mature and ready yet? Not completely. There are still key challenges, such as computational and energy efficiency, interoperability between blockchains, speed and volume of transactions and jurisdiction of data and these are being addressed right now. However, now is the right time to begin collaborating with industry and academia as the need for productivity and efficiency in the public sector has never been greater.

Innovate UK is keen to foster this dynamic through our research and development competition that is open to projects for disruptive and game-changing ideas in any sector of the economy or any field of technology. They can be of various kinds, from small feasibility studies to longer industrial research or experimental development projects and the competition it is open to businesses working alone or with other businesses and researchers.

> "What exactly is blockchain? Put simply, a shared and decentralised database that has data mutually agreed upon through consensus. One application of this is blockchain, where a time-stamped and integrity-checked record is added sequentially and linked to previous transactions."

What if you're ready to take the plunge? First and foremost, don't rush into deploying blockchain without understanding why you need it. Blockchains aren't needed for everything and could cause unnecessary complexity and cost. However, if you determine that a blockchain could be of benefit, also consider the process implications to your organisation and those whom you share information with. Think of it at 20% technology adoption and 80% organisational change. ■

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Crypto assets and the regulator's role: Ignore, regulate or kill?

Dr. Paolo Tasca and Professor Tomaso Aste from the UCL Centre for Blockchain in London, share their expert views on crypto assets and the regulator's role in this vein

The increasing development of new industries and inventions has always fascinated jurists: the field of new technologies has been a fertile ground for scholars to address legal issues ever since the advent of digital technologies and it has inevitably led to the intertwining of technology and regulation.

Regulation is about altering the behaviours of others with the intention of producing a specific outcome (Black, 2002) and when it comes to new technologies, the outcome is always that of avoiding the perceived risk a given technology may cause to society (Yeung 2017). The more the perceived risk is believed to be contagious, the more the regulatory action will be invasive. However, the human perception of risks is reasonably influenced by the current state-of-the-art knowledge surrounding a given technology, and it is at the same time, depending on its development: the newer the technology, the higher the perceived risk. Therefore, it is fruitful to analyse every technology's regulation through the lens of the technology-life cycle model which builds upon the theory of the product life cycle.

During the first stage, known as the *introduction stage* (Yoo, 2010), a company launches a new technological product but, due to the initial small size of the market, the legislative authorities often ignore it. Bitcoin is a notable example of this phenomenon: although today authorities are focusing more extensively on Bitcoin, at its inception they were fully unaware of its existence since it was small in size and mostly used as a mean to perform transactions in the Dark Web (Tasca et al., 2016). In this phase, regulators tend to be sceptical towards the technological progress and firstly, they approach the new technology without sensing that they may need to be specifically regulated or controlled.

When the cycle reaches the *growth stage* and the market starts making room for the new product, legislative authorities usually ignore it until it starts posing regulatory issues. When the product shows potential risks for social justice and (traditional) markets dynamics, authorities step in (Yeung et al 2007). The European Banking Authority (EBA), for instance, issued several warnings to inform consumers on the risks related to trading cryptocurrencies and discouraged banks from accepting them (EBA Opinion on virtual currencies, 2014). At this stage, regulators are in listening-learning mode and instead of passing strict legislations, they typically prefer a "sandbox approach", which leaves space for experiments in the development of new products or services. This allows regulatory bodies to determine whether they need to create new rules and to adapt pre-existent ones. Notable are the regulatory sandbox initiative by e.g., the Canadian Security Administrators (CSA) or the UK Financial Conduct Authority (FCA).

Conversely, the European Central Bank (ECB), while acknowledging that the regulatory vacuum of virtual currencies may favour criminals, did not believe necessary to complement the current European framework with a specific regulation (ECB Virtual currency schemes 2012, 2015); a view shared by the EU Parliament so far, which has not adopted any resolution yet on the matter but instead created a European blockchain observatory.

As the technological artefact reaches a systemically relevant market share – the *maturity stage* – the legislator has either provided it with soft regulations or tried to fit it inside a "pre-existing regulatory matrix" (Bennet Moses, 2013). That is what happened in June 2017, with the Security Exchange Commission's (SEC's) report on Decentralised Autonomous Organisations (DAOs). Whatever dumbfounded reactions one may have had, the SEC made it clear: depending on the facts and circumstances of each individual Initial Coin Offering (ICO), the virtual coins or tokens that are offered or sold may be securities. And so, if they are securities, the offer and sale of these virtual coins or tokens in an ICO are subject to the federal security law.

However, not only this approach does not render justice to the specificity of each project, but in most cases it proves unsuccessful. In fact, technology regulation inevitably faces the challenge of "regulatory connection",

namely "the mismatch between current laws and regulatory approaches", as the latter were intended to shape a technological scenario that belongs to the past and is no longer existing (Brownsword, 2008). This pacing issue is mainly due to the Collingridge dilemma (Collingridge, 1980), according to which regulation is problematic both at an early and at a later stage of technologies' development. In fact, in the first stage uncertainty makes regulation hard, whereas and in the second stage, the reached market share makes regulation excessively expensive. This is also the case with nanotechnologies: as some scholars have pointed out, by far it is unlikely that the current patchwork of regulations, which is several decades old and it was thought to tackle the issues raised by the last industrial revolution, will be able to successfully deal with the forthcoming scenario (Wardak, 2006).

Similarly, if financial regulation does not keep the pace with the ever-increasing development of the crypto-space, distributed ledger technologies may be left alone to regulate themselves in what someone called "The Wild West of Cryptocurrencies" (Singh, 2015). Notwithstanding the SEC's approach to utility tokens, for example, new DAOs projects have arisen that tend to circumvent financial regulation. Hence, it is not surprising that regulatory authorities are increasingly scared that new technologies may have a microseeds-terminator-effect (The Economist, 1999), forcing their users and the entire market to be locked under their rules once they've been adopted. And it is not surprising either that public authorities in most cases tend to fiercely react with top-down rules that shut down a new technology product. That is what happened with the ban of ICOs in China and South Korea, which ended up in considering those operations as a potential threat to financial stability and capital control. In this sense, regulators risk falling in the trap of safeguarding safety by killing innovation.

In conclusion, there are three different attitudes of regulation corresponding to the stage of development of a technology. Initially, regulators ignore technologies; when they cannot do it any longer they step in cautiously; and finally, when the perceived risks for society overweigh the overall benefit for it, they ban or heavily regulate technological artefacts and their applications. In so doing, they contribute to the last *decline stage* of a technology – the fourth phase of the cycle – until a new technology reborns from ashes.

Even if blockchain technologies have not reached their *maturity stage*, some regulators have started to take serious actions to prevent risky and contagious effects. The community of blockchain innovators must become more aware of the "ignore, regulate or kill it" 3-stage regulators' approach to innovation and prevent to end up in the third stage by coordinating development actions with the regulatory body before it will be too late.

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Could blockchain provide a boost to post-Brexit farming?

University of Hull, School of Politics, Philosophy and International Studies, Graduate Student, Tom Jones, asks if blockchain technology might provide a boost to post-Brexit farming

Brexit hangs heavily in the air around Britain's countryside now. For anyone working in the industry, it is almost inescapable. British farmers face a high degree of uncertainty, unsure as to whether they will be able to continue exporting to Europe along current lines or whether they will face total regulatory divergence from the continent. To boot, there is the huge potential impact of a border between the Republic and Northern Ireland, which could prove highly disruptive to agriculture on the island of Ireland.

Agriculture is one of the few areas of industry that would not suffer because of moving to WTO rules. A tariff-free Brexit, however, in which the government allows open access to agricultural produce from nations with lower environmental standards (and therefore lower costs) would see the domestic market share of British farmers largely undercut by foreign producers, particularly towards the bottom end of the market. As well as the significant potential threat from cheap foreign imports, however, British agriculture also faces the prospect of being drastically ill-equipped to succeed, once outside of the EU, on the international export market.

82% of all meat exports and 74% of cereal exports are to the EU and the UK's largest agricultural export market is Ireland, followed by the US and France – two of which would be heavily affected by a loss of an EU trade deal. There is also a skew towards importation in every food product category except drink, with fruit, veg, dairy and fish being the most pronounced imbalances. This heavy overexposure to threatened European markets is coupled to the fact that British agriculture, which is currently largely shielded from market forces by large EU subsidies, is suffering from a productivity crisis.

Agriculture is currently Britain's least productive industry (measured in terms of output in £ per hour) (it is worth noting, however, that agriculture is a key input into the food and drink sector, which is more productive than the UK economy on average). In comparison to productivity to the other 28 EU nations (those with common standards), the UK ranks 19th in terms of output per hectare. In value terms, it produces less than an eighth as much as the Netherlands per hectare of agricultural land. If Britain were to suddenly face direct competition with these far more productive nations, it is doubtless that the flaws of the sector would soon be exposed on the export market.

As Britain seeks a new relationship with Europe, farmers are developing a freshly renewed interest in the export sector and in how they can develop their produce with a point of difference, to give them an advantage when marketing their produce across the world. In her first speech as NFU President, Minette Batters spoke of her desire to capitalise on a 'new dawn for farming' and for 'Ministers to recognise the global opportunities there are for British farmed food and drink.' Mrs Batters is

helped in this quest by the Minister currently at the head of DEFRA, Michael Gove, a man who has bought a reforming zeal to every ministerial post he has held.

The recently published 'Health and Harmony: the future for food, farming and the environment in a Green Brexit' vigorously advances the fundamental idea of 'public money for public goods', which Mr Gove has advocated since he entered office. This is the idea that farm subsidies, currently dictated by the Brussels-produced Common Agricultural Policy (CAP), will become, once decided by the UK government, linked to ideas of 'public good', such as environmentally friendly farming methods, conservation and the production of healthy foods. As well as investing in a new type of farm subsidy to secure post-Brexit British agriculture, the Business Secretary Greg Clarke announced that the government would invest £90 million in agricultural technology, to help raise British agricultural productivity and at the same time 'future-proof' farming.

There is one technology which could enable the government to combine their drive for increased productivity, public goods and increased exports. This is blockchain.

Most commonly associated with cryptocurrency, blockchain technology allows users to store data and information along every link in the chain; this allows users to track transfer history and means the end user can be provided with reliable information about a product's origin. In August of last year, for example, IBM's blockchain division partnered with huge food suppliers such as Walmart, Unilever and Nestlé in the US to carry out a pilot. This was designed to test blockchain's ability to provide added consumer confidence by offering them access to and information on the supplier's global chain - in this case, on mangoes. The challenge was relatively simple; to trace the origin of a mango back through a global supply chain. Without blockchain, this took almost a week. But utilising the data collated and held by blockchain, however, the exercise was reduced to two seconds.

An increase in the use of blockchain in agriculture could give British farmers the edge they need over competitors on the international export market. British produce is sold at the more expensive end of the market, but with the reputation of strong and reliable quality.

> "As Britain seeks a new relationship with Europe, farmers are developing a freshly renewed interest in the export sector and in how they can develop their produce with a point of difference, to give them an advantage when marketing their produce across the world."

The current trend for consumption in developed nations is heading away from low-cost produce manufacturer on an industrial scale and towards high quality.

The possible mass-scale integration of blockchain into the British agricultural supply chain could provide the point of difference between British exports and produce from other nations with equally high welfare and environmental standards.

Enabling end users to verify that your free-range pork, for instance, was indeed free range, would see consumer trust in British exports soar, building a trusted brand which, when wedded to a strong marketing message and a recognisable brand (a function which the Red Tractor already performs admirably) would position British exporters in an enviable position. The added value of offering end customers traceability would also offer a real point of difference against competitors - particularly those with high but relatively similar standards of welfare, such as other members of the EU. Blockchain could yet be the key point of difference British farming needs to successfully market its products to the world. ■

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Blockchain: Potential to benefit public services and modernise bureaucracies

Stig Østergaard Nielsen from the Nordic Blockchain Association argues that blockchain can benefit public services and modernise bureaucracies

Blockchain technology has been heralded as a future pillar of information-technology by enthusiasts and thinkers, from Copenhagen to Karachi. As a base-technology that can satisfy a demand for high transparency, with clear accountability and expedient operations as well as truly globalised business, the future of blockchain points in many directions.

At one extreme, blockchain is viewed as the prime-disrupter of our time, a technology that could fundamentally change the way society is run. Some have even suggested that in time, blockchain could enable safe and efficient direct democracies with little need for parliaments or politicians.

Public-sector entities certainly have a large role to play in shaping the future of the technology as developing-partners, working to leverage the technology to modernise bureaucratic procedure, public administration and governance. In this iteration of the blockchain-future, innovative public actors willing to invest in small-scale development projects have much to gain in the future.

The basics

Blockchain like any other new technology is, of course, a very complex subject. Explaining it in a few sentences is complicated and risks painting an oversimplified picture and the same goes for its potential applications, in the public sphere and elsewhere.

However, for the purpose of this article, consider this. A blockchain is a ledger that registers transactions (changing data). The links in the chain are blocks of data updated regularly and stacked chronologically on top of one another. The chain exists in multiple identical copies across a network (usually public) and all records are checked against each other continuously to ensure consensus. Once blocks are linked to the distributed network, single actors cannot corrupt or change data in the ledger, making the network hard to tamper with, so it is both transparent and trustworthy.

Layers of automation, known as smart-contracts, can be added to the chain, enabling different types of business to be conducted without humans checking the process manually. Put simply, a business process like buying a watch online can be conducted purely by "if-then" procedures like; "IF" ordered and paid for, then it was approved and shipped – theoretically saving time without sacrificing safety.

This article from Computerworld does a nice job explaining the basic qualities of blockchain.

Heightened efficiency

Basic bureaucracies, that is the well-functioning uncorrupted kind, have much in common with the very simplified version of an "if-then" contract as described above. Take applying for housing subsidies in Denmark as an example. In essence, all citizens are potentially eligible to have a fraction of their rent-money reimbursed, provided they fulfil a specific list of criteria. These criteria are complex, yet analogous to the "IF" in the model above. The "then" is the approval and the eventual reimbursement of funds. The basic function of the procedure is ensuring a fair and equal treatment of all applicants, under the current law. However, the current system experiences a fair share of criticism and is often said to be slow, overly cumbersome and rigid.

While the rigidity is a logical consequence of complex rules, the "IF", the speed of the process leading to "then" is determined by the amount of organic computer power employed by a given bureaucracy.

Smart-contracts (of varying complexity), in combination with the hard-to-hack qualities of blockchain, offer a way to speed up bureaucratic processes and it follows that this would also free up resources to be allocated elsewhere or simply eliminated, depending on the political priorities of the day.

"Public-sector entities certainly have a large role to play in shaping the future of the technology as developing-partners, working to leverage the technology to modernise bureaucratic procedure, public administration and governance. In this iteration of the blockchain-future, innovative public actors willing to invest in small-scale development projects have much to gain in the future".

Real world examples

There are an increasing amount of real-world examples of blockchain projects for public development available around the world. They are, of course, complicated to explain and deserve a more detailed treatment than the scope of this article offers. The examples below are, however, worth investigating further.

Currently, one of the most impressive collections of blockchain concepts and projects resides with the organisation, Dutch Blockchain Pilots. In Holland, the organisation has orchestrated a large number of pilot-projects addressing challenges like slow processing procedures for child care payments and the identification of broken streetlights (using supplementary technology) and the following dispatch of a repairman and payment. Ultimately, this is heightening efficiency and easing workloads.

Publications like "Using Blockchain To Improve Data Management In The Public Sector" from Mckinsey or "Blockchain: Opportunities for Healthcare" from Deloitte offer insights on several additional pilots and potential blockchain applications, including efficient remittance payment systems and secure personal data sharing solutions between public authorities.

In Scandinavia, the Nordic Blockchain Association is leading a similar effort to establish pilot-projects in partnership between public actors and private developers in conjunction with the organisation behind the Dutch Blockchain Pilots, working towards an early introduction of blockchain in public.

At the heart of the effort lies the recognition that blockchain, despite all its qualities and increasing salience in public debate is still a young technology, no longer the infant stage of existence, but still in a formative period, as well as the belief that the technology's prospective benefits are worth pursuing with consolidated efforts.

Early beginnings

Clearly, blockchain has the potential to affect changes in public administration and provide updates to old structures of administration and the success and progress of initiatives like the Dutch Blockchain Pilots prove that blockchain pilots are viable options. However, to fully capitalise on potential gains, more development is needed and more public entities will have to establish pilot-projects for several reasons.

Government structures are very large and notoriously slow to change, of course, thus there is a need for a long learning period, as well as plenty time for adjustment is expected. Early engagement with the development of blockchain projects offers a gradual learning period and opportunities to shape the ideal design on an extended timeline.

Small-scale explorative projects offer developers – often hungry start-ups – and public players the opportunity to grow concepts at a healthy equal pace with ample time to grow ambitions, understanding and capability at a common pace.

It is also valuable to consider that the process of legislative catch-up to disruptions in both public administration and private industry can be better informed with the government as an insider and development partner. ■

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Stick or twist: Perspectives from the world's largest blockchain event

In May this year, New York held the largest Blockchain conference yet – Consensus 2018. Here are a personal set of perspectives about the event which should get you scratching your head about blockchain from Simon Kavanagh, Head of Innovation and Design in Healthcare, Welfare and Education at Tieto

The event was part of the inaugural "New York Blockchain Week" and there was certainly a push to attract crypto-talent and by extension, crypto-cash to the City. The wildly fluctuating cryptocurrency market has seen Bitcoin prices go from $1,000 to almost $20,000 within eight months in 2017. All this movement has resulted in the current dollar market value of all cryptocurrencies being a healthy $355 billion. Hype, boom, bust, bubble? Either way, that is a lot of potential. Cryptocurrencies are the new kids on the trading block and they have a long way to go but they are certainly here to stay.

During the Consensus, this was a general feeling: Blockchain and the underlying Distributed Ledger Technology (DLT), is at the edge of something about to really take off. It's becoming more mainstream. But at the same time, it needs to take a great leap forward and there was no clear indication of what that leap is or where it will take it.

Greed, fear & wide-eyed hope

Consensus 2018 was arranged by Coindesk, "the leading digital media, events and information services company for the crypto asset and blockchain technology community". Ticket prices were over $2,500. At over 8,500 attendees, that's a cool $21 million total of revenue. This is one of the sticky points about blockchain right now. How could a technology, which was established as a way to circumvent the power of large corporations in controlling wealth, end up making a lot of money for venture capitalists? How is it that the NYSE, Goldman Sachs and other incumbent financial institutions look to be the ones to capitalise on blockchain? There was no obvious rebellion among the participants, but there was unease. At least one notable DLT personality, Vitalik Buterin, co-founder of Ethereum had boycotted the event.

Broadly speaking, the reasons why people were attending were greed, fear and hope. Some attended because they were pushing something themselves, their new technology and their company. Pitching was everywhere. Of course, it's unfair to label all this as greed. It's just business. But there was a definite sense of grabbing territory and staking claims before everyone else gets there. Then there were those who were attending out of fear, lest their company become the next Kodak, Nokia or Blockbuster.

If everyone is investing in blockchain, then we should also, or we will be left on the scrap heap. This is understandable, but it's also a circular argument. Everyone should be interested in blockchain because it seems that everyone is interested in it. Genuine, wide-eyed hope and calls for social justice did pop up as reasons to attend, but they were rare.

> "Cryptocurrencies are the new kids on the trading block and they have a long way to go but they are certainly here to stay."

In one "fireside chat", two panellists began a side debate on how far-reaching the surveillance capabilities of the FBI and NSA are. The bottom line here, is that some blockchains are safer than transacting on the wider internet, but they are not foolproof either. In the same discussion, Edward Snowden was quoted. In the constant pushing, selling and positioning which went on for most of the time, this was a refreshing glimpse of the original libertarian principles behind DLT.

Where was Uber in 1998?

In the dotcom, bubble internet was really slow which limited what could be done with it. From a corporate perspective, the urgency was in creating a website. You had to have a digital presence to match your bricks-and-mortar presence. Very few people could predict where things were going beyond having a website. This was when enormous amounts of money were being invested in infrastructure which would someday host a different

sort of service. No one could have predicted Uber in 1998, because so many of the prerequisites had yet to be invented: 4G, publicly available GPS, smartphones, touch interaction, long-lasting battery and so on. Yet, even though no one predicted Uber, there were huge investments in exactly these technologies. This is where we are with blockchain. No one really knows what type of businesses and services the global DLT infrastructure will host, but we need to continue to invest and refine the technology regardless. We need to work away at the limitations of blockchain technology so that the solutions of tomorrows can arrive. And there are some serious limitations with blockchain right now which need to be solved.

> "If everyone is investing in blockchain, then we should also, or we will be left on the scrap heap. This is understandable, but it's also a circular argument."

Slow, volatile and hungry

The global Bitcoin network, by far the biggest instance of DLT, can process about seven transactions a second. There are about 28 million Bitcoin wallets, but most Bitcoin users have multiple wallets, so the number of Bitcoin users is most likely less than this. The current technology and infrastructure have serious performance problems when scaling. In addition, current transaction fees are around $1 but peaked at $34 at the end of 2017. As money was pouring into the market, then fees increased.

There are rival cryptocurrency networks aimed at faster transaction resolution and lower transaction fees, but volatile is a fitting adjective for the current state of play. A lot has been written about how much energy it takes to power the Bitcoin network. Bitcoin miners, who are ultimately responsible for resolving consensus and processing transactions, invest in power-hungry, dedicated mining hardware and consume a LOT of energy. The global Bitcoin network energy consumption rose from 11 Twh (Terawatt Hour) in May last year, to 68 Twh now. Oslo, the capital of Norway has 1.3 million inhabitants and consumes only 9 Twh per year, about 13% of what Bitcoin does. And things are only getting worse.

Stick or twist?

Consensus 2018 was all about the mainstream, with a strong presence from the three largest capacity vendors IBM, Microsoft and AWS pushing their blockchain cloud offerings forward. The most impressive corporate presence was FedEx. It is doubling down on blockchain, despite problems with the current iterations and the noise, hype, dead ends and uncertainty. This is surely an indication of how impactful this technology is and how much it is going to transform businesses in the next 10 years. Right now, it's a game of blackjack and the question everyone is asking is, "do I stick or twist"?

Key areas to observe for the public sector
The regulation of:

- ICO's. Great opportunity for entrepreneurs to get funding. New opportunity for investors. The regulatory framework is missing.
- Cryptocurrencies: have the opportunity to connect the unbanked population to the digital economy.
- GDPR and blockchain. By design, 'pure' blockchains are immutable. Is there any guidance from public authorities how to meet GDPR requirements when using blockchain?

Opportunities for:

- Self-sovereign identity and digitalisation of society. The public sector should participate in SSI initiatives to drive the full digitalisation of societies.

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The current status of blockchain technologies

Marta Pierkarska, Director of Developer Ecosystem at Hyperledger reveals her thoughts on the current status of blockchain technologies

We are midway through 2018 and it seems everyone has bought into blockchain. But have they really?

When we go to staple industry conferences, it definitely feels like there is not a single person in the world that has not heard about blockchain. At Hyperledger, we are proud and grateful to get public and social media attention. We have almost 45,000 Twitter followers and a webinar series where our community can learn, on a monthly basis, about blockchain and our frameworks.

> "Governments, while struggling to regulate cryptocurrencies and ICOs, are absolutely bought into the blockchain space. Today, there are 203 different initiatives around the world implementing solutions in different governments."

Thankfully, though, we also get invited to speak at conferences that are not industry specific. That's where we learn that not everyone is crazy about blockchain. Many have often never even heard about it! From big to small, there is a whole world outside of our echo chamber. They ask: "what is blockchain?" and "how is it different from a database?", "can I have a blockchain where I don't share any information with anyone?" and, of course, "what is the killer app for blockchain?"

It is good to step out of the comfort zone. It challenges us to look from the outside and ask: "what is the adoption of blockchain in enterprises today?"

Hyperledger has now reached almost 250 members, showing how much interest there is in enterprise blockchain applications. If you belong to the Innovators on the Rogers' Diffusion Curve, then 2018 is a year of deployment. We see enterprises going live with their platforms in the supply chain, financial technologies, healthcare and the government. In fact, the need for a collaboration platform was so high that we have launched Public Sector and Healthcare Working Groups.

The working groups reflect a significant shift in thinking from those getting deeper into the deployment process. While developing Proofs of Concept, enterprises believed that one can simply do it alone. That there can be one blockchain per company and the technologist can develop ways for the ledgers to talk to each other. However, blockchain is a Peer-to-Peer network. To scale and make use of its full benefits peers, or nodes should come from different parties. This means evolving from "blockchain is a decentralised database system" to "blockchain is a distributed record of data" mindset. The shift has led to the creation of a number of consortia in various domains since the beginning of 2018. Some examples: we.trade, developed by nine different banks; TReDS, a similar platform in India; the Intelligent Healthcare Network for claims management in healthcare and Realtor® Association Blockchain, which created regional repositories of activity of their 1,200 members. This aim for collaboration and modularity shows a new level of maturity in the space.

Not everyone is crazy about blockchain though. Many are still looking to understand the return on investment in the blockchain space. Or are still looking at how to choose the right technologies – ones that will scale with time – and for the right use cases. Is it better to use a sniper approach and target a small number of big projects or a machine gun one: blockchain everything and see what sticks? Which of the solutions implemented today will stand the test of users and time? Frustration when experimenting with blockchain is unavoidable. Departments spent money on horizon 2 projects, but only a few of them can move to horizon 1. Even then it requires more financial engagement.

Blockchain will not solve all our problems and will not be valuable in all industries. All sectors are facing challenges around security, as well as the usability of the newly developed DLT-based projects. While blockchain is being used for security updates in The Internet of Things (IoT) or a better voting mechanism, it also brings new attack vectors. Questions arise about how we evaluate smart contracts, how we ensure the consensus cannot be broken, what information should be stored on a blockchain and how. On the usability front, there is a need for better user interfaces and the integration tools to encourage a wider adoption.

The maturing market is starting to ask the right questions and new industries are adopting the technology. Governments, while struggling to regulate cryptocurrencies and ICOs, are absolutely bought into the blockchain space. Today, there are 203 different initiatives around the world implementing solutions in different governments. In art and music for IP protection and proof of provenance, in shipping and logistics for a bill of lading or in education for certification storage, there is growing interest and increasing adoption. Still, there remains a huge demand for education. Not only on what blockchain is, but also how to share data through a blockchain, while preserving the most important IP in enterprises and PI in the case of individuals. As with any new technology, the demand is there but supply remains scarce. But we are getting there. ■

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Technology and social media: An ethical focus

In this opinion article, President of the BCS, The Chartered Institute for IT, Chris Rees reveals why he thinks that technology, including social media, must be ethical

The reaction to the sudden and continued news coverage of Cambridge Analytica's use of Facebook's user data has been telling. Much of the press, public and our own MPs expressed shock, confusion and outrage at what has emerged.

The reaction was one of horror: a company had been collecting information about us (and our friends) from the web and using it to profile and target each of us with specific advertising that an algorithm had decided was most likely to appeal to us? This was done not only to convince us to buy products or services but also to sway our political opinions too? And none of this was illegal? Disgusting. Terrifying. Immoral.

The other prominent reaction to the allegations, often from columnists, was one of frustration that any of this was 'news' at all. Of course, your data was being collected and sold to the highest bidder, they said. Did you think Facebook and the various other free online platforms you were using were not-for-profit organisations, supplying the world with communications networks out of the goodness of their hearts? It's not Cambridge Analytica you have a problem with; it's Facebook's entire business model and those of many other digital companies whose services you use daily. This is what we've been trying to tell you, they said; yes, the situation is troubling, but it should hardly come as a surprise.

Whatever your viewpoint, these developments exposed the gap that exists between the public's use of new technologies and their awareness or understanding of how they work. Questions of who designed these new technologies, how they were created and whether they were implemented with the interests of the user or society in mind, all seem to be gaining public traction in a way we have not previously seen. Some people even closed their Facebook accounts in disgust!

Chris Rees, President

And this issue is only going to grow in prominence. Rapid developments in machine learning and artificial intelligence (AI), whether in the context of job-stealing automation or the benefits and dangers of self-driving cars, are pushing the subject of ethical behaviours in IT to the front of both social and political debate.

Surely, we need to get to a situation where the IT professionals creating these products and services are confident that what they are doing is entirely ethical, at every stage from inception to implementation. Yet, unlike medical professionals who have a long-standing, well-supported ethical focus, this approach may well be challenging for individuals without support for their upholding of an established ethical doctrine.

In our dynamic tech world, there are likely to be frequent instances when an ethical approach may appear slower or costlier than one which bends the rules or pushes the boundaries. That's without mentioning those instances where an individual's career may be at risk if they refuse to cut corners or make decisions they know to be ethically dubious.

No one wants to slow the pace of positive innovation. The challenge, therefore, is to create a culture that enables a competitive advantage to exist for tech companies that abide by ethical standards. This should demonstrate how the tech companies, consumers and society as a whole can benefit from the IT industry taking responsibility for their actions under a new 'social contract'.

Bias in AI decision making, transparency around how they reach their conclusions, liability when things go wrong... there are some big topics which need addressing when considering how to implement ethical considerations into the IT sector.

The task of ensuring that ethical considerations are firmly embedded into every stage and aspect of the tech industry is an ambitious one, but in many ways, it is also obvious and well-overdue. A lack of basic understanding around IT and how tech companies operate, both amongst the public and those in positions of authority, is no small barrier to initiating a full public debate on the subject.

However, with continued coverage of the issue and many commentators suggesting we are at 'crunch-point' where public awareness of and attitudes towards tech companies is shifting, perhaps we are now approaching the moment where we can do more to ensure that IT is good for society.

A new cross-party Parliamentary Commission on Technology Ethics is being launched by two MPs (Labour's Darren Jones and Conservative Lee Rowley), with the help of Oxford University's Professor Luciano Floridi and BCS, The Chartered Institute for IT.

Over the course of the next 12 months, the Commission will be looking at a range of key areas around the subject of tech ethics, aiming to recommend substantive policy changes that can have some practical impact. The Commission will be inviting stakeholder evidence throughout its investigation and I would encourage anyone with opinions on this most timely of issues to follow and feed into its progress by emailing us at policyhub@bcs.uk. ■

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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.

The importance of having established GDPR-compliant policies

Andrew Cowling, Channel Marketing Specialist at Fujitsu Scanners imparts his expertise on why it is important to consider digital processes to help towards GDPR-compliance and the wider digital transformation benefits

Last month saw the introduction of the GDPR and brings harmonisation across the EU regards data privacy. This is no Y2K and will not go away so it is imperative if you havent started already on the journey towards GDPR compliance that you must ensure within your organisation that anyone holding personally identifiable data can prove the consent, the security and management of that data. There are a number of questions that data holders need to ask themselves:

1. Right to access – can you find all the data you hold on an individual, how quickly can you respond to SARs?

2. Retention periods – do you know how long you can lawfully hold the data for?

3. Data erasure – are you confident that the right of an individual to be forgotten can be met and that every single trace can be removed?

4. Privacy by design – are you building in security steps from the outset?

5. Security – how many copies of your documents exist?

6. Consent – do you have consent to hold the data and how will you use it?

7. Audit trails – GDPR is not just about being compliant but proving it in a court of law – can you confidently prove your processes are lawful?

When it comes to achieving GDPR compliance the starting point recommended is to conduct an assessment of the relevant data held today and where it resides – opening with the digitisation of paper-based documents through scanning and merging with any digitally born material.

More than just compliance

While GDPR is a strong reason, there are a number of reasons for organisations to additionally embrace moving from paper to digital processes.

Investment in digital transformation now can deliver savings and efficiencies across the whole business, as well as helping to prepare for future regulatory compliance, legislation can be a powerful tool to drive a cultural change, so GDPR should also be seen in that light.

These benefits include:

- Better organised data, all stored in one place;
- Increased storage capabilities with Cloud-based servers;
- Quicker to both find and retrieve files;
- Ability to manage data more effectively;
- Easier to share information/files between colleagues and across office locations;
- Increased efficiencies/time savings for administrative staff;
- Increased office space with less physical filing and;
- Greater security of data.

Deliver business efficiencies while helping to achieve compliance with GDPR. The potential risks associated with GDPR – most notably the fines and reputation – mean organisations simply have to be prepared.

Fujitsu is working with a number of partners on specific solutions for the public sector looking in depth at areas such as SARs, retention periods and data handling and now have a solution that offers a methodical and structured approach to GDPR with impressive deployment and proven track record success in addressing stringent German privacy laws over the last decade. If you'd like to know more then please contact us today.

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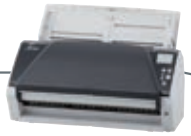

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Accelerate your business with imec's new 'Corporate Accelerator' program

Sven De Cleyn explains how imec's business accelerator program can help larger companies to fine-tune and launch their tech innovations

Imec is opening its imec.istart business accelerator program – originally targeted at start-ups – to larger companies, providing them with a safe and inspiring environment to further fine-tune and launch their tech ideas.

Fast-paced technological and digital (r)evolutions are continuously disrupting traditional markets. To cope with these disruptions, large corporations typically engage in corporate venturing projects that enable them to connect and partner with promising, innovative start-ups.

But innovation does not always have to come from outside the company. Most corporations do have the capabilities to come up with great new business ideas. Unfortunately, because many of these projects are too high-risk or too far removed from the company's current core business, they are often dismissed and stashed away.

Sven De Cleyn (imec.istart program manager) explains more: "Though these companies have the resources to explore these innovative ideas, they choose not to, so as not to dilute their established brand name. What they need is a new approach, radically different from internal venturing or R&D; an approach that allows them to explore their idea's business potential in a more neutral and inspiring setting, isolated from the company's current core activities and daily operations."

To encourage companies not to let these ideas gather dust on the shelf, imec is now opening its imec.istart business accelerator program, which originally targeted tech start-ups, to large corporations as well.

> "In summary, the main advantage of this corporate imec.istart program is that companies can explore potential new business opportunities in a safe and inspiring ecosystem that fosters innovation."

What is imec.istart?

The imec.istart program is a business accelerator program that helps tech start-ups get their business off the ground. For 12 to 18 months, selected start-ups get the opportunity to enjoy the program's support package, including specialised workshops, useful facilities such as office space, and access to imec's wide network of partners in the tech industry. The program was founded in 2011 and has gathered a lot of traction since. Amongst others, it has been recognised by UBI Global as one of the best business accelerator programs worldwide.

At the moment, the imec.istart portfolio consists of over 140 tech start-ups, creating over 1,000 full-time jobs and reaching an annual turnover of 188 million euros in 2016. The aim of the imec.istart program is not only to guide start-ups through the first couple of months of their existence but also to help them become scale-ups. For instance, each year the imec.istart team organises an Investors' Day, which provides the entrepreneurs with the opportunity to pitch their ideas to potential investors that are part of imec's network.

The imec.istart team also regularly organises field-specific international missions, lowering the threshold for start-ups to explore new markets abroad. Moreover, collaboration initiatives (such as EuroIncNet) have been set up with a number of other top accelerators in Europe. And these extra efforts pay off: imec.istart was even listed as the most successful European accelerator when it comes to creating scale-ups in the 2016 Europe Scale Up Report.

Launching a corporate's innovation as if it were a start-up

The imec.istart team is continuously looking for new ways to stimulate innovation. Within this framework, they have recently decided to open up the imec.istart program to established companies as well. More specifically, they are focusing on larger companies that are interested in exploring new business ideas for digital or technological innovation.

Sven De Cleyn explains more on this point concerning innovation: "At the moment, we're already in contact with two larger corporations that are interested in joining our program. The idea is to launch their innovation on the

market as if it were a start-up. They choose a team of employees that can pull the project and get to join our 12- to 18-month support program. During this period, they get to enjoy all the same perks and benefits as our start-ups."

More specifically, the corporate team can attend hands-on workshops and one-on-one support sessions with industry experts. They also receive support and counselling from imec's experienced experts in residence who help them get off to a flying start.

Another important advantage is that they gain access to imec's in-house technical expertise, its global network of partners in the tech industry, as well as imec's infrastructure of cleanrooms, test labs and smart spaces.

In addition, imec houses its own living labs team that can support entrepreneurs with thorough user involvement research, from co-creating to prototyping to business modelling. With imec.livinglabs' support, entrepreneurs can make sure that their solution truly meets users' needs.

Sven De Cleyn is keen to explain more about the program's benefits in his own words: "In summary, the main advantage of this corporate imec.istart program is that companies can explore potential new business opportunities in a safe and inspiring ecosystem that fosters innovation. During the program, we manage their project as if it were a start-up, but at the end of the track, the companies can still choose whether to continue the business as a separate start-up or spin-off, or whether they want to integrate the technology into their main offering.

"We offer these services in return for a consultancy fee, so we don't claim any IP or take any financial stake in the business. It's a unique opportunity for larger corporations to ride the wave of innovation and creativity that is so omnipresent in the start-up scene."

Are you interested in joining the imec.istart program or looking for more information? Then take a look at the imec.istart website or contact Sven De Cleyn (imec.istart program manager) directly at sven.decleyn@imec.be.

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How can UK law enforcement join forces to combat digital crime?

John Wright, Senior Industry Director, Unisys details how UK law enforcement can join forces to combat today's digital crime

Across the country, police agencies have been hit by a growing tidal wave of criminality through the medium of cyber – an area in which they are lacking resource to be able to effectively investigate.

In fact, last year's Crime Survey for England and Wales discovered that 1.2 million people fell victim to computer misuse offences – in real-life terms, that equates to an average person being roughly 11 times more likely to fall victim to computer misuse than a robbery.

With cybercrime posing an ever-growing threat to the nation, police forces across the country are feeling the strain. How can police forces be prepared to tackle this ever-increasing 'invisible' threat?

Shared knowledge needed to fight cybercrime

Currently, the recording of fraud and cyber-crime is handled by Action Fraud, whilst local forces continue to be responsible for protecting their local communities against those who commit a crime and for supporting those who fall victim to it.

However, a recent report by Her Majesty's Inspectorate of Constabulary and Fire & Rescue Services (HMICFRS) revealed that there is a lack of an effective response to fraud at a local level, with one chief officer source noting chief constables considered that they had: "given [fraud] in its entirety to Action Fraud."

Given that the National Fraud Intelligence Bureau provides forces, monthly, with details of all victims of fraud and cyber-dependent crime in their force areas, such cases shouldn't be left solely to Action Fraud to investigate and provide much of the heavy lifting – there needs to be a change in culture.

John Wright
Senior Industry Director

Individual forces should, therefore, sign up to the approach that is currently being developed by the National Police Chiefs Council – a national strategy in which all expertise and best practices across multiple forces are better aligned, thus increasing the capabilities to respond to these threats by sharing knowledge across all agencies.

> "Cybercrime is a major issue now that is only going to increase, such crimes cannot be handled solely by the likes Action Fraud to tackle. If cybercrime continues to be investigated by a relatively small number of centralised investigators, this will rapidly de-skill the vast majority of law enforcers that are available."

By taking a joined-up approach, police officers can start to upskill themselves through the expertise they gain from working with the other agencies. With an

increased understanding of the digital crime landscape, this will allow forces to better triage these incidents and effectively identify those with a greater likelihood of successful investigation, better managing the currently scarce resources.

Not only this, but opening different agencies to collaboration will improve the overall awareness of cyber issues to law enforcement officers. To be able to provide effective support and advice to victims, officers need to understand the significance of online fraud and the impact that data breaches and anti-social behaviour can have.

Additionally, with officers understanding which cases should be referred to Action Fraud and those that need a more immediate response, cases can be handled in a more streamlined fashion.

In turn, this awareness piece will also enable constabularies to have a better grasp on their internal cybersecurity as their employees will understand the importance of good security practices and the effect it could have on the organisation.

A growing threat that's only going to increase

Cybercrime is a major issue now that is only going to increase, such crimes cannot be handled solely by the likes Action Fraud to tackle.

If cybercrime continues to be investigated by a relatively small number of centralised investigators, this will rapidly de-skill the vast majority of law enforcers that are available. In turn, this could ultimately exacerbate the problem as, when this type of criminality evolves, local forces will lose their ability to respond and will potentially lose public confidence.

Deploying cyber-enabled investigators across the country and increasing the capabilities of local law enforcement agencies is vital to tackling this problem. The investigators can divide and conquer cybercrime through allocating resource to priority locations and share resources. In doing so, the police service will also be able to establish the scale and impact of cybercrime, at both a national and local level and learn how to better respond. ■

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The EU's new General Data Protection Regulation (GDPR)

Andrew Davidson, Head of Marketing, Cyber Security EMEIA at Fujitsu shares his seasoned opinion on the EU's new General Data Protection Regulation (GDPR) and reveals that the devil is in the data

A recent joint article chose a revealing headline: 'GDPR: the new data-protection law giving watchdogs a mega-bite.' Much of the coverage of the EU's new General Data Protection Regulation (GDPR) has been focused on the possibility of huge fines being levied on companies that fail to comply with the provisions of GDPR. But at Fujitsu, we prefer to accentuate the positive.

The new regulation is an opportunity. EU statutory regulators agree. They have indicated that companies which distinguish their products and services by data privacy standards will win more business.

This is not only an obligation but an opportunity. With compliance comes competitive advantage, as organisations can better utilise the data at their disposal, gain critical insights and build trusted relationships.

By approaching GDPR from the perspective of people, process and technology as well as enabling digital transformation, you can make the most of the opportunity.

GDPR is not about technology

GDPR is about protecting the personal data of individuals. Technology will help you to do that, but the emphasis needs to be on achieving a holistic view of all the data that you hold and process. To do that you need good policies and governance. Your processes, systems and technologies then need to be aligned with those policies.

In that way, everything you do can be linked back to the basic principles outlined in GDPR and you will be able to not only comply with the regulation, but achieve significant benefits for your business, your people and your stakeholders.

That's what we mean by the 'devil is in the data' – look closely at the demands of GDPR, understand what you need to do at all levels of your organisation. That's important because every enterprise is complex and there's always a risk of data getting lost or duplicated across functions and within them.

Achieving better visibility can deliver a lot of benefits to the way you operate and the information you can leverage.

Focus on people

The principles behind GDPR are founded in the EU Charter of Fundamental Human Rights. Regulation is a positive step forward for the rights of citizens to have more control of their personal data and to engage with organisations which hold and process it in positive ways.

We believe that this human-centric view of GDPR should be the foundation for how organisations comply with GDPR. It's not just another regulatory burden, but a means by which better-managed quality information can directly contribute to business improvements and efficiencies with the needs and rights of peoples placed firmly at the heart of the entire exercise.

It is often hard for businesses to create a true sense of ownership when it comes to dealing with privacy issues around personal data. It's been seen as an issue for lawyers or compliance specialists. It's not considered a core part of the business. That also used to be the case for cybersecurity, but the recurrence of high-profile breaches which have affected the reputations of global organisations has transformed that mindset. It is now well understood that investment in cybersecurity not only delivers higher levels of protection, but also engenders trust. This is what we are seeing with GDPR which aims to give individuals more ownership and control over what's happening to their personal data, even if most people won't notice the difference in their daily lives.

Your focus needs to be on the interests of data subjects – people – employees, customers and all stakeholders. Everyone you come into contact with. Their interests are the principal focus, not just technology.

Data is at the core of all businesses

You need to build a culture of exem-

plary data governance. Know what data you have, where it is, what it's for and who has access to it. Organisations need to own the responsibility for protecting the privacy of their customers and employees by designing compliant business processes, based on appropriate technology, to collect and processes personal data.

Effective data governance and management need to be considered holistically, rather than in silos. In an era of cheap storage, many organisations have just stored data without really understanding whether that data is still required. This goes against the GDPR concept of data minimisation – which is to only hold the minimum amount of data required and only for legitimate purposes.

Understand your data, make it visible

In a world replete with threats, a lack of visibility and understanding represents the biggest danger for organisations, not just in terms of GDPR, but across but for organisational effectiveness too.

Hackers know that personal data can be profitable, so they will attempt to steal it. And, it's not just cyber that counts: data can be lost in many other ways. Poor practices can see data lost through using unsecured Wi-Fi in public places or printing out documents and then not shredding them. Good lifecycle management of data in all its forms is vital.

As digitalisation projects gather pace and the Internet of Things (IoT) devices like wearable or remote sensors gather increasing volumes of data (from video to numbers to sound and biometrics), you must get ahead of the data curve.

It's all part of your digital transformation

At Fujitsu, we believe that your approach to GDPR should be based not just on compliance, but also on contributing to your digital transformation. Data, as we've stressed, is at the heart of any modern enterprise. You need to embark on a journey that ensures you know where and how to invest in locating, managing and protecting and utilising your data to its maximum potential. Complying with GDPR can kick-start this.

And it's not just about personal data. We're arguing for a holistic approach to ALL data. Make it the core of your digital future. Achieving high-quality information and data management can be a differentiator in a dynamic marketplace. Seeing it in this way will help you make the investment case for a robust and creative approach to your data management and governance.

People, policy and processes and technology that deliver 'privacy by nature.'

GDPR calls for organisations to achieve its principles 'by design' which means that when they are developing, designing, selecting and using applications, services and products which are based on the processing of personal data or do so to fulfil their task, then the protection of that data must be designed into them from the start. Our approach extends that principle to everything you do to achieve what we call 'privacy by nature'.

People, policy and process are key to the former. Technical controls consist of applications, infrastructure and security. It sounds obvious, but the key is to ensure that it's all done logically and in the right way. You need to understand the needs and expectations of all stakeholders as well as understand the rights and freedoms of data subjects (as defined by GDPR).

You need to understand all the categories of data you hold – and all the sensitivities associated with them. That will enable you to ensure you have categorised the data correctly and then understand what needs to be done to protect its integrity. This helps you define policies and processes. Once they're locked down, you can understand the technology you need to deploy to locate, manage and protect the data. So, for instance, you have to ensure that your systems make it possible to find personal data, extract it and, if necessary, amend or delete it. Ideally, that needs to happen at the application level and filter through to the underpinning infrastructure.

The end game is to ensure 'privacy by nature' – it's fundamental to what you do and who you are. That's why people are the priority. To achieve that balance of people, policies and processes and then achieve the right level of sophistication at the application, infrastructure and security levels takes work. For many, it's not something they want to do alone. Which is where a co-creation partner comes in as well as an ecosystem.

Talk to Fujitsu about how you can make the most of the GDPR opportunity.
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The GDS: Leading digital, data and technology for the UK government

The work of the Government Digital Service (GDS) in leading lead the digital, data and technology function for the UK government is examined here by Open Access Government

The Government Digital Service (GDS), part of Cabinet Office, helps UK government departments work together to transform the government and meet the needs of users. The GDS employs more than 500 staff all over the UK and their main office is based in Aldgate, London. The GDS's responsibilities encompass providing the best practice guidance and advice for coherent, consistent and high-quality services. The GDS also identifies the needs for common services, components and tools, some of which they build themselves.

The GDS also helps departments to run model projects with the government and other partners to demonstrate what can be achieved. They also help the government to choose the right technology and, in this vein, the GDS favours shorter, more flexible relationships with a wide variety of suppliers. The GDS also plays an important role in setting and enforcing standards for digital services, as well as leading the all-important digital, data and technology function for the UK government.[1]

The current Director General of the GDS is Kevin Cunnington, who has held this prestigious position since August 2016. During his professional career, Kevin has led a number of large-scale and global, digital transformation programmes. His early career was spent in the world of programming and IT consultancy, but more recently he was the Global Head of Online for Vodafone Group and Business Transformation Group Director General at the Department for Work and Pensions (DWP).[2]

Delivering IT and digital products and services

One aspect of the GDS's work is highlighted in their blog, which explains that during the past five years, the GDS has helped save over £1 billion by working with departments to identify cheaper and better ways to deliver IT, digital products and services. As part of this process, we discover that the GDS works collaboratively with departments before they even begin to create digital services. In their blog, the GDS explains more on this point in their own words.

"The spend controls process was introduced in 2010. But time and technology moves on. We want to make sure that it continues to be as effective as possible and that it gives departments the support they need.

"One aspect of the GDS's work is highlighted in their blog, which explains that during the past five years, the GDS has helped save over £1 billion by working with departments to identify cheaper and better ways to deliver IT, digital products and services. As part of this process, we discover that the GDS works collaboratively with departments before they even begin to create digital services."

"We've previously written about all the work and research we've done to improve the spend controls process. We've looked at providing earlier engagement and greater collaboration with departments as well as giving support where it is needed and when it is needed."

Based on this research, the GDS has developed a new approach, which they have piloted with four departments. Now, the GDS is ready to roll out the new spend controls process more widely. In this vein, one of the things they are doing is to put a pipeline in place, something they elaborate on as described below.

"When we carried out research with departments, they told us they wanted more autonomy to assure their own projects and programmes, where appropriate. They also said they wanted to make it easier to jointly determine where and how help is provided.

Image: © Crown copyright

Kevin Cunnington, Director General, Government Digital Service

"To enable this, we're introducing a new system that we call a pipeline approach. This means that rather than looking at individual services or technology projects, we're going to work with departments to develop a 15 to 18-month forward-look at all their commercial, digital and technology spend. We will look at all digital and technology activity, rather than just looking at spend above a certain threshold.

"Work in the pipeline will be assured against the government standards, such as the recently updated Technology Code of Practice. This will show us where and how the GDS and departments need to work together to improve things. This is a more agile, iterative model which will rely on and strengthen departments' existing governance processes."[3]

In closing, it's worth considering that the GDS is following this pilot with four departments and they're now ready to roll out the new process to a small number of additional departments. The recently published new spend controls guidance for IT and digital[4] was collaboratively penned by five departments working with a technical writer to ensure clarity. The process, we discover, has not been dictated by the centre of the UK government, but it has been built with and for users in departments. The GDS intends to work with departments that have a pipeline ready and have their own design authorities, as laid out in the Government Transformation Strategy.[5] ■

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Digital transformation in the public sector

Peter Miller from Visionist explains the challenge of enabling digital transformation in the public sector, including progressive ways of working such as Agile

Following a successful partnership, to turn around and deliver an in-flight large business critical digital transformation programme, Visionist were invited by a large London NHS Trust to design a new in-house front office digital transformation function, the Digital Hub, that would utilise the progressive new ways of working (Lean Start-up and Agile) that had enabled the in-flight programme turnaround and success. Visionist was also challenged with the design of a new, radically different funding model to support the new ways of working to ensure annual recurrent budget availability based on in-year cashable benefits. The digital hub would need to focus on front office service directly impacting both patient and clinician.

"Founded back in 2003, Visionist has over 15 years government delivery experience and 20 years' experience in delivering digital transformation to large organisations and not for profits."

The challenge would be the design of a set of standard operating processes to transition Visionist's methods and ways of working into a BAU function. This function would be made up of predominantly permanent staff members, and underpinned by the establishment a new organisational culture and attitude that understood the benefits of delivering a minimum viable product and using data-driven decision making to recognise and deliver transformation opportunities. At the heart of the new culture was a "positive experience". Efficiencies must also equal improvements and experiences for patients and clinicians.

Any digital transformation strategy that had access to a BAU annual recurrent budget, rather than a project capital budget, would need to be to be able to deliver a proven approach for real business change and the associated transformational processes and elements that come with it.

The focus of the strategy would be on the development and deployment of transformation enabling operating processes supported by customer-facing digital products and services that would deliver against the trust's digital agenda and maximise the return on investment in the year.

The process

In order to enable the trust to achieve their objective of true digital reform, a shift in focus from the available technology capabilities was required. A fundamental change to business processes enabled and encouraged new ways of working, which were supported by new technology to deliver strategic business-based outcomes and create positive user (patient and clinician) experiences.

To make this a reality, Visionist worked closely with the trust to analyse and document their current processes and capabilities, thus defining the 'as is' state. Through strategic workshops, process audits and patient and clinician research, the desired future (to be) state was imagined, and a target operating model (TOM) was drawn up. The TOM was fundamental in underpinning the business case design and supported the trusts benefit realisation plans bringing everything together. Visionist then led supplier negotiations and statement of work agreements for the foundation of a new digital service unit called 'The Digital Hub'.

This new service unit would go on to facilitate a dedicated, cross-disciplined, agile and transformation/change team of over 20 professionals to deliver organisational effectiveness, new processes and capabilities and improvements to the patient and clinical experiences across the NHS trust. Once a standard operational model had been established, Visionist went on to oversee the re-skilling of staff before transitioning the new service unit from consultant and contract lead resource to a BaU run function. Visionist are highly regarded by my colleagues, and across our organisation as a whole.

Front office digital transformation: Delivering customer facing organisational improvements and effectiveness.

The digital transformation achieved 500% cashable in year benefits.

The outcome

The Digital Hub is a highly successful

function at the NHS trust, both supporting the digital agenda and informing the overall digital strategy as well as delivering in year cashable benefits. It is a catalyst for health innovation, positive patient experiences and continues to deliver year on year cost savings generating new revenue for the trust. Since the launch of The Digital Hub, the NHS trust continues to transform the way it provides clinical care to patients, with over 400% cashable in year benefits achieved. The Digital Hub is helping the NHS to maximise its efficiency by providing better patient outcomes, reducing the demand for current resourcing while also building a more sustainable future for the NHS.

- Delivery of a new service unit dedicated to delivering innovation.
- Enhanced system and capability effectiveness.
- Better engagement with clinicians and healthcare experts.
- Reduced demand on existing resources.
- Proven better patient outcomes and.
- New digital first culture.

About Visionist

Founded back in 2003, Visionist has over 15 years government delivery experience and 20 years' experience in delivering digital transformation to large organisations and not for profits. We have over 100 permanent staff, and our wider resource pool includes over 800 subject matter experts from our subcontractors and long-term associates, who collectively cover all of the skills and knowledge areas required. The associates that we work with all share our values and commitment to delivering a high-quality service. Many have worked with us for some years across multiple projects and complement our permanent team with additional niche subject matter expertise or delivery experience.

To digitally transform your organisation let's talk +44 (0)20 3883 8201 or visit www.visionist.consulting .

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Increasing productivity through online collaboration

Jason Fahy, CEO, Knowledge Hub explains how organisations are increasing productivity through collaboration

For 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.

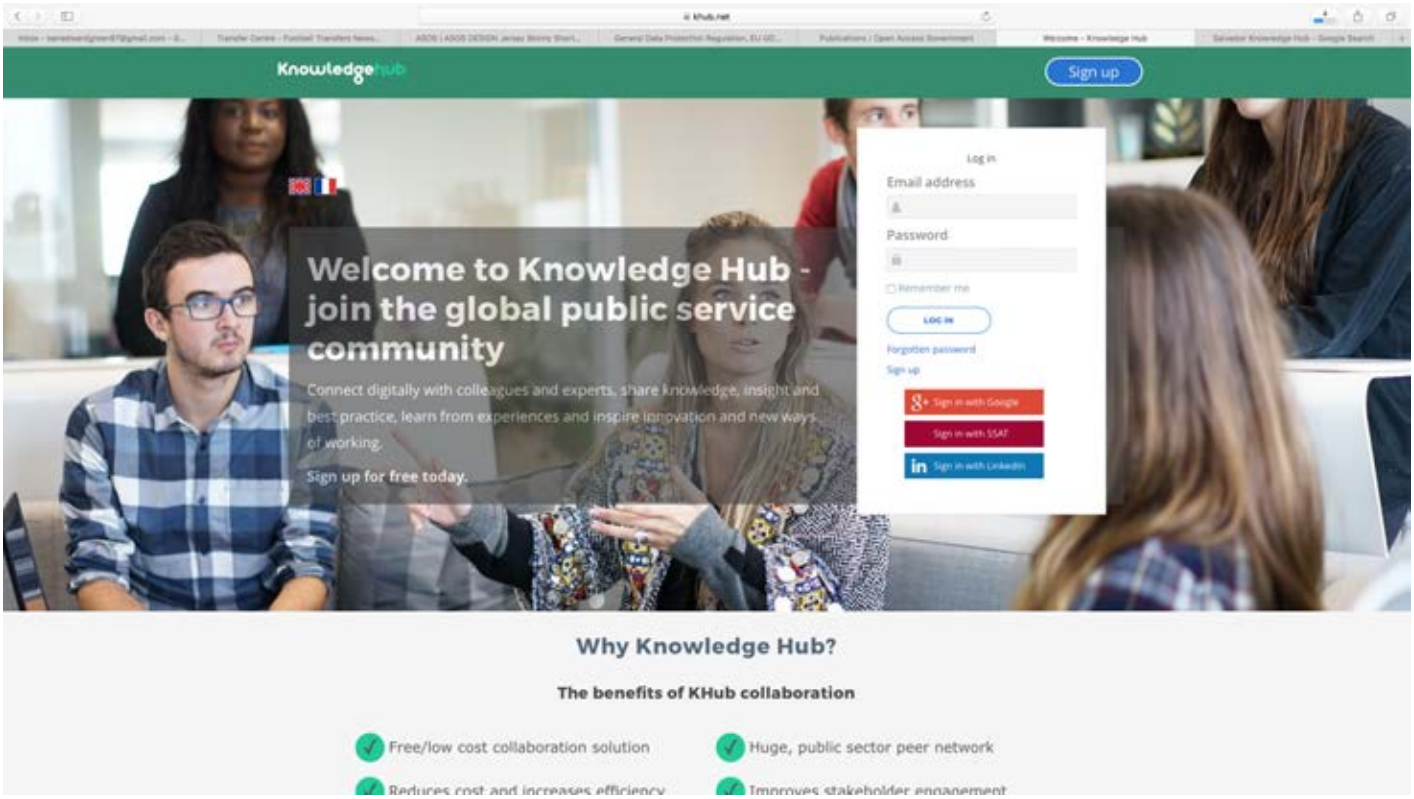
> "We talk about our desire to make a difference as a business and it feels as if we can now achieve this on a global level by increasing the productivity of 100 RC member cities through collaboration."

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 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.

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 engineering 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 .

SALVADOR RESILIENTE
SALVADOR PREFEITURA
PRIMEIRA CAPITAL DO BRASIL

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ICT disaggregation: Nobody ever got fired for hiring...

Mark Hastings of Rainmaker Solutions prescribes the antidote to SI addiction: ICT disaggregation

Ever since former Cabinet Office minister Francis Maude vowed to break the centre's addiction to the "IT oligopoly" back in 2011, the UK government has been promoting the benefits of ICT disaggregation.

Last November, the Cabinet Office reiterated its guidance to departments, pointing out that large outsourcing contracts, often single vendor arrangements lasting from five to ten years, no longer represented value for money and constrained departments from delivering ICT that met the needs of users and which enabled better ways of working.

But there are worrying signs that the guidance is still poorly understood. We read regularly, in the media, that departments are struggling to break their addiction to large suppliers, often resorting to multiple contract extensions with no real competition, or replacing one outsourcing giant with another, despite ICT provision being inadequate, programmes years behind schedule and millions of pounds over budget.

This is a dangerous game. The recent collapse of outsourcer Carillion and the well-documented problems at large Systems Integrators (SIs) are a reminder of the risks.

An unwillingness to reform, whether down to the scale and complexity of incumbent programmes, the distraction of Brexit, or a lack of in-house expertise, perpetuates the cycle of archaic infrastructure, sub-standard ICT, inflexible lock-ins and exorbitant change requests.

There is a better way. The Cabinet Office champions disaggregation because it reduces the costs of ICT provision, provides a more flexible model that is able to respond to a more volatile, uncertain, complex and ambiguous world and delivers ICT that better meets user needs.

But a successful disaggregation programme isn't about the technology, it's about a compelling and ambitious business vision. It's about the users and their needs, now and in the future. Rather than focusing on insourcing versus outsourcing, it turns a spotlight on smart-sourcing; a balance between developing unique and novel components in-house and making the best use of products and commodities available in the technology marketplace.

Disaggregation requires an understanding of the integration points between technology and its users. It demands a significant change in mindset. It pushes departments to encourage personal and collective empowerment across the ICT estate and develop new skills, so staff can take control and ownership for delivery.

This is the approach we took at the Food Standards Agency, where we were able to untangle them from complex legacy technology, transforming their estate, digital services and processes to enable better ways of working. In doing so, the FSA was able to save 40% of its ICT run costs and transfer key knowledge to the in-house team, with a return on investment within 12 months. It is this approach which sees us working in partnership with MHCLG and London Borough of Croydon, to help them navigate their own disaggregation programmes.

Mark Hastings
Rainmaker Solutions

If you want to break an addiction to large SIs and need help to kick-start your journey, speak to a partner at Rainmaker Solutions with a deep understanding of disaggregation. Resorting to the status quo is no longer acceptable. As Francis Maude said, "No one ever got fired for hiring...". Well, perhaps they should have been.

rainmaker

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HM Revenue & Customs

P45 Part 1A

Details of employee leaving work

Copy for employee

1

Title - enter MR, MRS, MISS or other title

Mr

Surname or family name

Lee. V

First names(s)

Mediately

2

Leaving date DD MM YYYY

3

Employer PAYE reference

Office number

Reference number

4

Employee national insurance no.

5

Reason for termination

For causing ongoing IT failures in the business.

Wasting millions on systems that don't deliver.

And locking us into long-term, archaic, legacy contracts.

6

Tax code at leaving date

7

Total tax to date

HMRC 02/18

Keep calm and carry on with a business continuity strategy

Jonathan Sharp, Director of Britannic Technologies explains the importance of an organisation having a business continuity strategy in place

Business continuity should be a mandatory requirement for any organisation. They should not come to a halt when faced with a disaster, albeit a terrorist or cybersecurity attack, severe weather or a power or technology outage. In today's 24/7 world, they must carry on providing services as usual. If they don't, they will damage their reputation and lose revenue.

Business continuity strategies are often given to the IT department to set up and manage and they only think about the technology and not the overall organisation, processes and people. This is usually why business continuity strategies fail.

When devising a business continuity strategy, you should consider the four P's: people (staff and customers), processes (the technology and processes required), premises and providers, suppliers and partners. This methodology enables you to take a holistic view of business continuity across the organisation.

Commitment from the top

The first step in the business continuity planning process is to get the commitment from the senior management team. It is then advisable to appoint someone to take ownership of the strategy.

Appoint an expert

It is also advisable to appoint a solutions provider who is accredited to the recognised business continuity standard of ISO 22301. They will help you in setting the strategy and ensure that you have the right technology in place for a resilient communications solution, so you can carry on working should a disaster occur.

What are the key services to our business?

It is vital to work out what is important to your organisation. Take your telecoms, for example. What would happen if you had a fire or a flood and your phones went down? List all the possible potential disasters that could happen.

What are the most critical services that you offer and what has the greatest impact on your organisation for your customers, suppliers and partners? What would need to get restored very quickly if a disaster occurred?

Processes: How do you deliver that?

What technology do we have to deliver the key processes, now that we have understood what we need and what the impact is? The longer operational disruption lasts, the more severe and costly the damage to your organisation and its reputation will be.

Connecting people

In the event of a disaster, staff may not be able to get to work and customers, partners and suppliers will not be able to contact them. Look at the different scenarios why staff might not be able to attend work such as snow, epidemic flu or an office fire. It is important to plan, how staff could continue to work and how you would disseminate information to customers, partners and suppliers.

Location transparency

If staff can't access your premises then they should be provided with technology that enables them to work from anywhere, so if a disaster arises they can carry on working from any location.

Jonathan Sharp, Director

Unified communications conferencing and collaboration solutions on mobiles and the desktop enable people to work from anywhere if there is an internet connection.

A solutions provider can assist you evaluating what technology you have in place and provide you with a resilient telephony solution and system. Do you have a duplicate server? Is your data backed up? Can you access your data quickly?

Secure in the Cloud

Cloud-based communications solutions are resilient and flexible, enabling you to keep everyone connected in the event of a disaster. It is a resilient platform that is a duplication of the technology systems that you use, so if a disaster occurs everything works on the duplicate server, allowing you to carry on working as usual. SIP telephony provides resiliency as it is a self-healing network with a failover network ensuring that the telephone system never goes down.

Safe in the hands of a solution provider

The benefit of working with a solutions provider is that they will provide a managed service for the resilient cloud solution, which frees up your IT team to focus on other areas. It also means that you have access to the latest technology without having to invest in the hardware or specialist ICT skills. They know the health of the network, the capacity and how well it is performing. They can also set parameters and alerts if the system starts to behave outside these parameters.

> "When devising a business continuity strategy, you should consider the 4 P's: people (staff and customers), processes (the technology and processes required), premises and providers, suppliers and partners. This methodology enables you to take a holistic view of business continuity across the organisation."

Federating with partners and suppliers

It is also imperative that you understand what business continuity plans your partners and suppliers have in place. If you rely on their network or systems and they suffer a disaster, how will this affect your operations?

An organic approach

A solutions provider will guide customers through this lengthy process, evaluating the risks, working out the different scenarios and the technology and processes that can be implemented to recover the business as fast as possible.

A business continuity strategy is the responsibility of the senior management team, not the IT department. It needs to be viewed as a business strategy and not a technology strategy. It is essential that everyone in the organisation is briefed and knows what their role is should a disaster occur. It is a circular process that constantly evolves and needs to be regularly fine-tuned and improved. It is a critical strategy that all organisations need to implement, so in the event of a disaster they can 'keep calm and carry on.' ■

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Preparedness can help your organisation survive the unexpected

Daren Howell from Sungard Availability Services explains exactly how preparedness can help your organisation survive the unexpected

Sungard Availability Services shares how being prepared for the worst enabled a customer to publish its daily newspapers on time and in full, despite being caught up in a terror attack on its doorstep. As well as having a duty to keep its workforce safe, the newspaper publisher had an obligation to its readers to continue reporting the news.

News publishing is an around-the-clock operation and just before 10 pm on Saturday 3 June 2017 – the night of the London Bridge and Borough Markets terror attacks – 204 employees were hard at work. The Sunday editions of the national papers had just been sent to the printers, but employees were still on shift to work on the online editions, particularly the tablet format, which are updated in real time.

A handful of journalists had left the building minutes before the combined vehicle ramming and stabbing attack that killed seven people and injured 48. One was clipped by the wing mirror of the terrorists' van and called in the story to the news desk. Two reporters left the building to investigate, escorted by a building security officer. On their way to Borough Market, hearing gunshots, they immediately made their way back to the newspaper offices. It quickly became clear that the team was in the middle of a terror attack taking place on their doorstep, with events unfolding rapidly.

The publisher activated incident management procedures and, prioritising occupants' safety, immediately took the decision to lock the building down.

Around 1 am – half an hour after the police had formally declared a terror incident – the company invoked its Workplace Recovery contract with Sungard Availability Services. Sungard AS swung into action to get the newly-refurbished recovery centre set-up to the predefined specification, ready to receive journalists and other staff before the start of the morning shift at 6.45 am.

However, it transpired that the company's designated recovery site would be inaccessible, being within the police cordon. This was not a problem as Sungard AS' rollback capability enables customers to recover to the next available facility, which was just over half a mile away.

The publisher's recovery was so effective that on Monday 5 June it produced full editions of its newspapers from the recovery facility. Crucially for the newspapers' distribution operation, it was able to honour the joint distribution agreements in place and avoid the additional costs incurred by delays.

Nonetheless, the publisher took away some learning points from its experience:

- While the publisher could redirect phones to the recovery site on a one-to-one basis, it has invested in an enhanced solution to more closely replicate its newsroom environment.
- Site visits were arranged to increase familiarity with the recovery facility.
- More pre-prepared communications templates were created to save valuable time in a crisis.

Public sector organisations quadrupled the sums spent on insuring against terror attacks in 2017[1]. Indeed, Southwark Council, whose headquarters building at 160 Tooley Street is just a short walk from London Bridge, has insured it for £34,000 to cover damage in the event of future attacks.

But while insurance will mitigate financial loss from a disaster or emergency, it will not protect an organisation from reputational damage or long-term losses due to its inability to recover or provide contracted services. In today's always-on environment, stakeholders will simply wonder why the organisation was not prepared.

1 Source: Tussell 2.1.18 https://www.telegraph.co.uk/business/2018/01/02/public-sector-quadruples-spending-terror-insurance/

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How Agile is the Government?

Agile business conference

"Agile development involves decision-making which is swift, and as close to the user as possible. This is not how decisions are made in government, with its overlapping layers of control from the centre and within departments and agencies."

- Daniel Thornton

Daniel Thornton

Daniel joined the Institute for Government in April 2015, after more than two decades of experience in the UK and international public service. He began his career in the Foreign Office, and subsequently worked in Parliament, HM Treasury, the Cabinet Office, 10 Downing Street and as a Director in the Department for Communities and Local Government.

There are significant challenges facing the public sector. Pressures on budget and resources form only part of the picture – the landscape of societal needs is changing so fast that a timely response is becoming more than difficult. We're in the digital age, and technology is changing our environment faster than we ever could have imagined. We can no longer predict what the future is likely to bring – all we know for certain is that we'll need to adapt, sometimes radically, to deal with it.

What is the impact on our public services? How can we best prepare ourselves and our organisations to thrive in such a volatile and uncertain world?

Agile Business Conference 2018

This is the challenge facing Generation Agile, and the theme of this year's Agile Business Conference on 26 & 27 September in London.

Daniel Thornton, Programme Director for The Institute for Government is hosting the conference and will be sharing his current thinking on the status of government agility. A regular speaker on the value of an Agile approach he says "Agile development involves decision-making which is swift, and as close to the user as possible. This is not how decisions are made in government, with its overlapping layers of control from the centre and within departments and agencies. Public servants need to learn the specialist skills to do this..."

Dr Sue Black OBE and UK Government advisor will be presenting the opening keynote. Recently named in the list of top 50 women in tech in Europe, Sue is one of the leading tech personalities in the UK today. An award-winning computer scientist, radical thinker, and social entrepreneur Sue is well known for founding the high-profile campaign to save Bletchley Park, capitalising upon social media as a fitting continuation of Bletchley's technological legacy.

In 2017 Sue received the Social Impact ABIE Award at the Grace Hopper Celebration, was made an OBE in the New Year Honours list 2016 and sits on the Government's new advisory board for improving digital services.

The power of agility

Organisations and government departments can no longer afford either to ignore the changes happening or to react too slowly to them. Success in the future will be for those that are highly responsive to change.

A recent survey showed that 94% of companies now use Agile in some form or another. This is an amazing figure, given that Agile as we know it only started in the 1990s. It also means that Agile is now an established way of working and can no longer be seen as a passing fad.

So, it is no surprise that many government organisations are adopting Agile as their preferred way of working. However, to be a real success, Agile adoption programmes must consider the need to change organisational culture and provide rigour and control while maintaining the fast-moving pace, dynamism and effectiveness of empowered, focused small teams.

Agile Digital Services (AgileDS)

The Government Digital Service (GDS) initiative has been a great success story and a testament to the power of an Agile approach. Did you know that the UK was named as number one in the world e-Government Survey commissioned by the United Nations? The UK also came out as the second most advanced digital nation in the world after the United States, according to research from consultancy Accenture in association with Oxford Economics. This is all critical groundwork and a solid foundation for the UK's future economic growth and development.

The success of GDS inspired the Agile Business Consortium to develop the Agile Digital Services (AgileDS) set of guidance which is moving into its public beta phase this summer.

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 multi-disciplinary service delivery teams as well as those who support them. People with a good grasp of established Agile methods can benefit from guidance on elements that may be new to them, such as approaches on user research. At the same time, AgileDS also covers the fundamentals of Agile culture and delivery as well as demystifying Agile jargon for civil servants and others who are new to Agile.

Be a part of the conversation

All this and more will be covered during the Agile Business Conference on 26 & 27 September in London. Join Daniel Thornton, Dr Sue Black and many other leading influential speakers to be a part of this critical conversation. How can we best prepare ourselves, and our government for Generation Agile?

Dr Sue Black OBE

Recently named in the list of top 50 women in tech in Europe, Sue is one of the leading tech personalities in the UK today. An award-winning computer scientist, radical thinker, and social entrepreneur Sue is well known for founding the high profile campaign to save Bletchley Park, capitalising upon social media as a fitting continuation of Bletchley's technological legacy.

Organised by

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Protecting the UK from the increasing cyber threat

Ciaran Martin, CEO of the NCSC, discusses how the UK and international partners are pushing back against state and criminal cyber aggression to help make the UK digital homeland significantly safer

The importance of cybersecurity has never been felt so acutely in our society. During April 2018, in an unprecedented joint statement with the American Government, the UK's National Cyber Security Centre publicly exposed an extensive and sustained Russian campaign of intrusions into the internet infrastructure of both countries. Cyber-attack is now a normal part of the arsenal of our adversaries, so we are on heightened alert for follow-up activity following the horrific event in Salisbury in March.

Ciaran Martin, CEO of the NCSC
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We have a choice about how to respond, as a country, to this type of aggression. It is easy to fall into the trap of seeing the problem as too complicated, too technical and too secret for organisations and individuals to do anything about. The UK government rejects this approach. With our partners, we are pushing back. We are working not just with the US but across our global network of allies to provide organisations and the public with the tools and information they need to push back with us. That's why the joint British and American report – twenty-one pages of detailed technical indicators – tells companies and public bodies how to identify and remove this hostile Russian presence. This is more about future risk than harm already done: an extensive Russian presence in our Internet infrastructure is not an acceptable national security risk for us as a nation to allow. If organisations here act on the advice given during the week beginning 16th April 2018 and report incidents, they will both protect themselves and help enhance our national intelligence picture of those who would do us harm, thereby making the UK digital homeland significantly safer.

There is more to cyber security, however than just countering Russia. None of us knows what the international security picture will look like in ten or twenty years' time. But we can assume there will be threats and that those seeking to do us harm will try to use the cyber domain to do so. That's why it is an urgent national priority to address two issues – protecting critical infrastructure, services and ourselves at all levels from cyber-attacks and the growing problem of rampant global cybercrime.

April's UK and US report is just part of a series of domestic and international measures aimed at reducing our vulnerabilities and those of our allies, in cyberspace. At the Commonwealth Summit in April this year, the leaders agreed a £15 million package to increase cybersecurity capabilities across the alliance. During April, the Prime Minister brought her counterparts from Canada, Australia and New Zealand to the UK's world-leading NCSC, a part of GCHQ, for discussions on coordinating our cyber defences. In the same month, the Home Secretary announced a plan to increase the capabilities of law enforcement to tackle cybercrime.

There is more to come. New measures introduced to parliament will help strengthen the cybersecurity of the UK's critical infrastructure. Turning off the lights and the power supply by cyber-attack is harder than Hollywood films sometimes make out. But we've seen enough malicious cyber-attacks across the world,

including against UK health services by a North Korean group last year, to know how services can be disrupted. Absolute protection is neither possible nor desirable; it's about having more resilience in the systems we care about the most, those where loss of service would have the most impact on our way of life. We have said that it is a matter of when, not if, the UK faces a serious cyber-attack. So, we presented detailed plans to government departments about the priority areas where the NCSC will work with them, industry and law enforcement to improve the cyber resilience of the most important systems.

Just as importantly, we must recognise that attackers, whether criminals or working for a hostile foreign government, exploit basic weaknesses. So, we are strengthening the UK's cyber defences in other ways, at all levels. One is by automation: 165 public sector organisations form part of a scheme that blocks access to sites we know to be related to cyber-attack. In April 2018, those organisations made 1.6 billion 'lookups' for internet sites, a quarter of a million of which we blocked because they were malicious.

We should avoid the temptation to succumb to despair when we think about cyber-attacks. There is cause for realistic optimism: the threats are there but whether they're from Russia, criminals or anyone else, we are putting in place national-level defences as good as anywhere in the world, but we cannot do it alone. Recent events have shown that we have the partnerships at home and abroad to secure our digital future and we need a national-level effort from all parts of our community to make those defences as effective as they can be. ■

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Developing cyber resilience skills in Scotland

Open Access Government explores the Scottish Government's recent initiatives to make Scotland a world-leading nation in cyber resilience by 2020, which includes putting cyber-skills at the centre of learning and development

In March this year, the Scottish Government put in place a new action plan to put cyber-skills at the centre of learning and development. The aim is to widen the awareness of cyber resilience and develop a strong pool of talent skilled in cybersecurity so that resilience to online and digital threats can be improved.

In short, the Cyber Resilience Learning and Skills Action Plan incorporates important actions for business, education and the public sector for strengthening and furthering understanding of the vital requirement for cybersecurity in today's world.

The action plan was launched by Economy Secretary Keith Brown earlier this year when meeting BT apprentices in Edinburgh as part of Scottish Apprenticeship Week 2018. He said:

"This plan is a blueprint for the Scottish Government and all its partners across the public and private sectors to work together to enhance our wider understanding of cybersecurity.

"We want to see people across Scotland, whether in early years, school, college or the workplace, get greater opportunities to develop the skills needed to be safe and resilient in their online lives.

"The plan also sets out how we can ensure we have a strong pool of professionals able to secure our businesses, charities and public services against current and future threats, and who can develop innovative goods and services for the rest of the world.

"Supporting the development of these specialist skills will be vital to the success of other activity on cyber resilience as well as our forthcoming plan to help us to take advantage of the economic opportunities presented by our work on cybersecurity."

SDS Director of Industry and Enterprise Networks, Gordon McGuinness welcomed the launch of the Cyber Resilience Learning and Skills Action Plan. His words conveyed his full support for increasing the awareness of cyber resilience in Scotland's schools, workplaces and further afield. He went on to explain his thoughts on cyber skills and why there are important for Scotland.

> "Worldwide, public services are being routinely and mercilessly subjected to low-level but high-volume attacks which capitalise on the complacency around basic cybersecurity measures, as well as more sophisticated and targeted cyber-attacks which in turn are impacting on the ability to provide essential health, social care and community services. This can also serve to undermine trust and confidence in the public sector."

"Cyber skills are a key focus for Skills Development Scotland. We launched our Cyber Skills Programme in 2017 which is an initiative encouraging school pupils to choose fighting cybercrime as a career choice."

"Through a series of collaborative events with industry, school pupils have been able to learn more about cybersecurity and the many exciting career opportunities that are available in this industry."[1]

Cybersecurity and its role in delivering digital public services to citizens

In a recent article from Open Access Government, John Swinney, Deputy First Minister of the Scottish Government shared his thoughts on the importance of cybersecurity and why it is an essential component of

John Swinney, Deputy First Minister of the Scottish

delivering digital public services to citizens. He also revealed the extent to which public services all over the world are impacted by cyber-attacks today.

"Worldwide, public services are being routinely and mercilessly subjected to low-level but high-volume attacks which capitalise on the complacency around basic cybersecurity measures, as well as more sophisticated and targeted cyber-attacks which in turn are impacting on the ability to provide essential health, social care and community services. This can also serve to undermine trust and confidence in the public sector."[2]

The Public Sector Action Plan on Cyber Resilience

John Swinney also refers to the Public Sector Action Plan on Cyber Resilience, launched in November 2017, which encourages all public bodies to implement the same baseline standards of cybersecurity within their organisations. At the time, Deputy First Minister John Swinney said:

"I want Scotland to be a world-leading nation in cyber resilience by 2020. The Scottish Government recently committed to developing a range of action plans to help meet this ambition, including in the key areas of learning and skills, economic opportunity, and public, private and third sector cyber resilience.

"Our public sector action plan will encourage all public bodies, large or small, to achieve common standards of cyber resilience. I want our public sector to lead by example on strengthening cybersecurity, to help ensure Scotland is ready to deal with all emerging threats."

In closing, Dr Keith Nicholson, Joint Chair of the NCRLB Public Sector Steering Group underlines one of the qualities of the public sector in Scotland, which is the willingness to share good practice and work together. He elaborates on this important point in his own words.

"The Public Sector Action Plan on Cyber Resilience is the embodiment of that spirit. All public bodies can follow the Action Plan to achieve a common base level of cybersecurity resilience ensuring that Scotland's public sector will be better protected against cyber-attacks to the benefit of both the organisation and the citizens of Scotland."[3] ■

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Business security challenges to the exponential growth of the Internet of Things (IoT)

James Aguilan, QA cybersecurity trainer at QA Limited details the business security challenges when it comes to the exponential growth of the Internet of Things (IoT)

The digital age has transformed virtually all aspects of everyday life. As data continues to migrate online, digital data becomes more pervasive. With the rise of the Internet of Things (IoT), cloud migration and extensive use of mobile applications, the cost of a data breach will increase.

Businesses are expected to be more 'inter-connected'. As employees and business partners work in businesses and require demanding access to corporate networks through the same mobile devices that they use in their personal lives and while smartphones and tablets upsurge connectivity, these present new types of security threats. To reinforce ties to customers and supply chains, businesses are encouraging vendors and customers to join their networks.

Malicious actors are more sophisticated and with the upsurge in the IoT, the rise of more threats is imminent. Political hacktivists, cybercrime organisations and state-sponsored groups have become technologically advanced, in such as a way that they are overtaking the skills and resources of corporate security teams. Malware has become more persistent, more difficult to trace and often customised to steal data that can be used for financial gain.

Developing a new business-driven cybersecurity model

Defending businesses technological assets from malicious damage and inappropriate use requires smart methods on how employees, customers and partners access corporate applications and data. Insufficient precautions will result in the loss of critical data; however, overly rigorous controls can get in the way of business operations or have other adverse effects.

For many businesses, cybersecurity has been treated primarily as a technology issue and many senior corporate leaders have too little understanding of the IT security risks and business implications to discuss the trade-offs for investment, risk and user behaviour.

However, taking a technical approach to solving the problem can have a negative effect on businesses by too tightly constraining how partners, suppliers, customers and employees interact with applications, data and physical infrastructure. There are seven steps to move toward a Business-driven cybersecurity model:

1. Executive level involvement – business and technology perspectives;

2. Classifying data risk across the enterprise and the entire value chain;

3. Identifying business processes and process participants accessing sensitive data;

4. Determining which applications have access to what data;

5. Balancing security effort, expense and impact on the business against the data risk profile;

6. Develop a comprehensive security model and;

7. Education and awareness.

Businesses will have to reverse their thinking to address cyber-risks. Businesses should first protect the most critical business assets or processes, rather than starting with technological vulnerabilities. Businesses have started to evaluate their cyber-risk profile across the full value chain, clarifying expectations with vendors and enhancing collaboration with key business partners.

Addressing rapidly evolving business needs and threat by invigorating cybersecurity strategies

It's no longer a matter of if a successful cyber-attack will happen, but when. Having the capability to detect and then outpace the attack itself can level the playing field for organisa-

tions experiencing a skills shortage. Currently, there are so many flaws in the academic model and the industry is forthrightly bad at selling itself at inspiring the next generation by showcasing that cybersecurity can be a stimulating and financially rewarding career.

In addition, training has over the past decade become almost exclusively product focused – with vendor 'academies' teaching individuals about specific product sets, rather than security framework requirements, a move that has further weakened the depth of expertise offered by any one individual. The only way businesses will be able to address the huge demand for cybersecurity skills will be to take control and invest.

Continuous education on awareness is vital, as new digital assets and mechanisms for accessing them mean new types of attacks. Many businesses are conducting simulated cyber-attacks to identify unexpected vulnerabilities and develop organisational policies for managing breaches, as well as outsourcing to educational providers in demand of secure coding and penetration testing.

However, cybercriminals are getting smarter at creating greater threats which can operate autonomously. Predictively, malware will be designed with adaptive, success-based learning to ensure the efficacy of attacks – meaning the next generation of malware will use code which is a forerunner to artificial intelligence (AI), including more complex decision-making trees. This new breed of autonomous malware works much in the same way as branch prediction technology.

What should senior executives do to ensure that cybersecurity is sufficiently addressed?

Many businesses have a misalignment between risk exposure and leaving businesses unprepared to stop data breaches because their security strategies and investments are not aligned to combat the primary threats they are facing. A study found that 60% of CEOs expect to invest the most in protecting against malware, rather than identity security solutions that protect against privileged access abuse and stolen passwords. These misinformed investment decisions pose a significant risk to organisations.

Cybersecurity should be a constant element on the agendas of management leadership. To stay ahead of the threats, executives must engage in an ongoing discussion to ensure their strategy continually evolves and makes the appropriate trade-offs between business opportunity and risks. Communication should start with several critical questions, which include:

1. Who is accountable for maintaining a cross-functional approach to cybersecurity?

2. Which assets are most critical and in the event of a breach what is the value at stake?

3. What roles do cybersecurity and trust play in our customer value proposition?

4. How are we using people, technology and processes, to protect critical information assets?

5. How are we adapting business processes accordingly as technology evolves?

6. How are we managing vendor and partner relationships to ensure the mutual protection?

7. How are we working with appropriate government entities to reduce cybersecurity threats?

> "As data continues to migrate online, digital data becomes more pervasive. With the rise of the Internet of Things (IoT), cloud migration and extensive use of mobile applications, the cost of a data breach will increase."

The cybersecurity challenge will only increase as more value migrates online and corporations adopt more innovative ways of interacting with customers and other partners. Companies need to make this a broad management initiative from senior leaders to protect critical information assets without placing constraints on business innovation and growth.

Visit cyber.qa.com for more information on how QA can help solve the cybersecurity skills gap.

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Security needs to be improved to protect against all vehicle attacks

Gavin Hepburn, Director at ATG Access argues that security needs to be improved to protect against all vehicle attacks – intentional or otherwise, in this opinion article

Throughout 2017, Europe fell victim to a series of tragic terror attacks that shook the western world. In April, an assailant drove a truck towards civilians in Stockholm. Then in June, a similar attack occurred on London Bridge, as again a vehicle was used to drive into pedestrians. And finally, in August, a van was used to harm pedestrians along the busy Las Ramblas in Barcelona.

Moving into 2018, the situation has only become more complicated, with security officials finding it even harder to predict and prevent future attacks. This is because not all vehicle attacks are the acts of terrorists looking to wreak havoc.

So far this year, two attacks have been carried out by individuals who have had no terrorist intentions or affiliations – one in Canada's capital city of Toronto and one in the German city of Muenster. Both incidents have highlighted that whether accidental or intentional and whatever the motive, future incidents can never be ruled out and improved safeguards are needed to protect crowded public areas.

What security measures are currently being used to prevent further attacks from taking place?

With attacks on the rise, governments are looking for urgent solutions to protect busy public spaces, such as promenades, urban squares, shopping streets and main café areas, which are increasingly becoming the primary target for these types of incidents. When large groups of people are gathered in one area, attackers can create a lot of damage in a short period of time using just a vehicle.

One security method that is proving popular with officials to safeguard these spaces is the installation of heavy-duty concrete barriers that can stop hostile vehicles in their tracks. These large barriers have already been installed across the globe, noticeably at locations that have previously fallen victim to an attack. Just days after the attack in Toronto this year, the concrete deterrents were installed at train stations and key public hotspots to prevent hostile vehicles from making contact with their targets.

Meanwhile, following the vehicle attacks on both the Westminster and London bridges, long concrete barriers have since been installed that span the full length of the bridges on either side. The aim is to prevent vehicles from mounting the pavements and going on to inflict irreparable damage or loss of innocent life.

But it wasn't just areas that had already experienced a terror attack that started to take preventative measures following the surge in vehicle incidents in 2017. Despite the increasing terror threat, the British public refused to let the fear of future attacks stop them from enjoying the festivities at Christmas – 47% still wanted to attend inclusive public events, such as Christmas markets, as long as visible bollards and barriers were put in place to protect the perimeter. In response, several UK councils installed concrete barriers around the perimeter of their Christmas markets to safeguard the events.

While the barriers do prevent vehicles from causing harm, they are not without their issues. Due to their size and crude appearance, they could act as a reminder to civilians that an attack is always likely, leaving the public feeling uneasy in their surroundings.

Alongside being aesthetically unappealing, these large barriers can also be potentially dangerous. In some cases, cycling lanes and pathways have been narrowed

to make way for these huge structures. The barriers on Westminster Bridge are a prime example, as cyclists are now having to cycle close to traffic because of the barriers' obtrusive presence.

Are there more effective solutions available?

The primary purpose of physical security measures is to protect, but this does not mean that they should make people feel uncomfortable or create a 'fortress mentality'. Security officials should be exploring solutions that are not only effective, but that can also blend into the background or fit around the existing infrastructure.

Given the high terror alert, the security industry has been working incredibly hard to develop a range of temporary hostile vehicle mitigation (HVM) barriers that are aesthetically pleasing, but also capable of bringing a large vehicle to a standstill. These barriers can be customised with symbols and slogans to help them fit into their surroundings - so, say if the barriers were installed at the recent royal wedding in Windsor, the barriers could have been decorated with royal murals, so as not to draw unneeded attention from the public.

Importantly, temporary HVM barriers have been designed to be permeable, meaning both pedestrians and cyclists can flow easily in and out of the systems. And as summer is now upon us, these barriers could be ideal to use when securing temporary pop-up events, such as farmers' markets and music festivals – events that play an integral part in making the UK more inclusive and diverse.

Sadly, vehicle attacks seem to be rising in popularity, not just from terrorists but also from individuals that just wish to cause harm. As a result, an attack can never be ruled out. With busy open areas now the new target of choice for attackers, effective solutions must be put in place that can keep people safe, whilst not creating greater levels of fear. ■

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Bolstering border control in the age of machine learning

Ray Batt, Director, Border Security Program, Global Public Sector at Unisys provides an expert perspective on bolstering border control in the age of machine learning

Terrorism, immigration and Brexit dominates today's headlines. The question of how to police Britain's borders is both politically charged and a matter of day-to-day concern for the Home Office, the HM Revenue & Customs (HMRC) and related departments.

This isn't just an issue for Britain. International cargo and traveller volumes are growing at an unprecedented rate. According to the World Tourism Organization, international tourist arrivals grew by a remarkable 7% in 2017 to reach a total of more than 1.3 billion – a number that is expected to increase by up to 5% in 2018. At the same time, international air freight is also experiencing annual double-digit growth.

While most of this traffic is legitimate and not a threat to public safety or state, border protection agencies and officers are under pressure to make accurate risk assessment judgements. Sometimes, this can be at the expense of the legitimate low-risk passengers and cargo, making efficient facilitation an issue for travellers and the freight industry. According to a recent study by the Imperial College London, Brexit talks are already sparking off speculation that the impact of EU customs checks could create 30-mile motorway jams.

The challenge to maintain the balance between facilitation of goods and people over security is a continuous feature of border control. Too often, the border authorities are impacted by many false positives that lead to the delay of both passengers and goods legitimately passing through the border. This incomplete information is often a major cause of incorrectly flagging low-risk as higher-risk targets for further inspection.

The decision to single out an individual or a piece of cargo as a potential threat requires multiple sources of information and data, the combination of which needs to be processed quickly and in as near real-time as possible. Currently, most border agencies rely on some form of simple pattern matching to detect threats.

However, this tends to be based on historical data available – and decisions can only be made based on predictable threat patterns, which is what often leads to false hits. In addition, if a shipment or perpetrator deviates from a recorded pattern then the matching systems are more likely to fail to identify and flag an alert.

"The challenge to maintain the balance between facilitation of goods and people over security is a continuous feature of border control. Too often, the border authorities are impacted by many false positives that lead to the delay of both passengers and goods legitimately passing through the border."

Machine learning is rapidly expanding the scope of the value of data – not just in terms of how data is managed but how it can be made to predict "most likely" scenarios. In the case of border control agencies, new advances in predictive analysis give border control agencies the ability to not just cumulatively learn from historical patterns, but also use statistical analysis to detect patterns that may represent new and emerging threats, which have not been detected previously.

Machine learning also enables more accurate decision-making. Ingesting varying types data types from multiple sources – the Home Office, HMRC, airports, airlines, intelligence and other law enforcement databases and

Image: © 1000words | Dreamstime.com

open source data – means a much deeper profile of a real threat can be developed and accessed. Importantly, with machine learning, the data makes the decision about which pieces of data are best utilised.

This approach is more likely to lead to faster and well-informed decisions, for border control staff to decide on what requires an intervention and what can be treated as a lower risk. Imagine a scenario for instance, where a border agent inspects a cargo shipment flagged as potentially risky and finds nothing, then that result goes back into the system and the targeting algorithms are automatically updated and applied to be more accurate the next time.

Border control is the collaborative responsibility of all the key stakeholders to ensure success. Globally, governments are recognising the immediate need to invest in bolstering intelligence and law enforcement teams. However, government investment in the right technology and infrastructure is also crucial to supporting these teams. By empowering and providing targeting tools powered by advances in machine learning, everyone from the government to legitimate travellers and consignments stands to benefit from a higher level of precision, efficiency and accuracy. Meanwhile, the free flow of people, goods and trade, which is essential to the UK economy, is not unduly interrupted. ■

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A new security standard for criminal vehicle impacts

Roger Knight, Marshalls' Head of New Product Development and Engineering for Landscape Protection, explains what the new PAS 170 security standard will provide and the benefits it will bring for businesses and government organisations in terms of criminal vehicle impacts

Criminal ram raids cost the public and private sectors millions of pounds in damages every year. But, up until now, there has been no tested and proven standard for an assured security product to protect against this risk.

The rise in vehicle-borne terror attacks triggered a rethink of how central government, local authorities and businesses protect people, buildings and infrastructure. The result has seen planners and security advisors place a strong focus on redesigning road layouts in heavily pedestrianised areas and installing perimeter protection that can stop a rogue vehicle travelling at high speed.

But, the growing number of criminal ram raids on commercial property across the UK and Europe, particularly on retail outlets and ATMs, poses a different challenge. The most recent European ATM Crime Report found that criminal attacks on ATMs increased by 80% year-on-year in the first half of 2016. In the UK, the Association of Convenience Stores found that the sector incurred more than £8 million in damages from ATM ram raids last year, with a further £38 million for robberies and burglaries, a high proportion of which involved a vehicle impact.

Rather than using Landscape Protection products manufactured to the British Standard Institution's (BSI) PAS

68 and IWA 14.1 standards, which have been installed in major cities across the UK and Europe to protect against terror attacks, mitigating against this threat requires a different approach.

PAS 170 – Assuring security products at low-speed impacts

For any planner or security expert, it's vital that the type of product installed is proportionate to the risk. In many situations where there is a criminal threat, such as a shop front, retail park or ATM, businesses and local authorities may only need security products that mitigate against vehicles travelling at lower speeds and not those manufactured to the highest specifications.

The government has introduced Publicly Available Specification (PAS) 170 to address this need – a new set of tested and proven standards that will ensure organisations can access an assured security product for this level of threat. The impact of this change will be significant as before now, no regulation of this type existed and the only lower-rated products available were 'anti-ram'.

PAS 170 delivers a testing standard for vehicles of up to 2.5 tonnes travelling at between 10 and 20 mph – significantly lower than the regulations developed to mitigate against vehicle-borne terror attacks (PAS 68 and IWA 14.1), where the testing weights typically range from 1.5 tonnes to 7.5 tonnes for speeds of either 30, 40 or 50mph.

This can provide organisations with a number of benefits.

The lighter weights and vehicle speeds mean that product manufacturers are able to conduct a greater number of tests with a wider range of vehicles. Together with being more cost-effective, the new standard will provide an organisation with more choice when it comes to picking the right type of security product for a particular space. There are a large number of scenarios where there could be no requirement to consider a product that can stop a 7.5-tonne articulated lorry travelling at 50mph.

Unlike previous anti-ram solutions, new products tested and certified by PAS 170 will provide businesses and local authorities with assurance and proof of performance for the first time. While this will help protect commercial property, using security approved by a government standard will also help reduce insurance premiums.

Following our latest round of testing at the HORIBA MIRA crash test centre, Marshalls now has four bollard cores which have been tested to the PAS170 standard and passed. All four were tested using a 2,500 trolley, with one using the impact of a vehicle travelling at 20mph, with the others at 10mph. Each one achieved a penetration distance of under two metres – the limit for securing the certification.

While it offers greater flexibility in specifying security measures, this new requirement is not intended to replace any element of the full-scale vehicle impact test methods, which were created and designed to mitigate against a vehicle-borne terrorist threat using unmodified commercial vehicles. These standards are set by The Home Office and Office for Security and Counter-Terrorism, together with key agencies The Centre for the Protection of National Infrastructure (CPNI) and The National Counter Terrorism Security Office (NaCTSO). They were developed to help government organisations assure levels of protection against intentional or accidental vehicle impacts and to ensure defences were customised to the risk profile of a specific site, such as a town square or high street.

Bespoke products to mitigate criminal activity

We understand that different businesses and organisations require bespoke Landscape Protection products. With this in mind, customers can work with Marshalls to integrate the new PAS 170 standards into different solutions, ranging from planters and seating through to bollards. This enables us to develop the right solution for the space that offers a combination of both safety and aesthetics.

> "The rise in vehicle-borne terror attacks triggered a rethink of how central government, local authorities and businesses protect people, buildings and infrastructure."

Whether government organisations or businesses are looking to mitigate against vehicle attacks linked to either terror or criminal activity, the key consideration is ensuring that the type of product they specify is proportionate to the level of threat. For the first time, planners and security specifiers will have the flexibility to procure an assured, certified product to mitigate against threats from lighter vehicles travelling at between 10 and 20mph intent on criminal damage or burglaries. This, in turn, will offer organisations a cost-effective method of protecting people certified to official standards that also take design and aesthetics into account.

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The future of Europe: The Euro

Eva Maydell MEP, Group of the European People's Party (Christian Democrats) shares her interesting views on the future of Europe, focussing on its most symbolic element, the Euro

With the next European elections approaching in about one year and the European debate gearing up all over the continent it looks more and more likely that the debate on the future of Europe will be determined by the future of its most symbolic element – the Euro.

After Brexit, the Eurozone economies will comprise 85% of the total GDP of the European Union. In the context of the discussions on a multi-speed Europe and the concrete proposals for deepening of the Euro area integration, it is likely that the Eurozone will increasingly become the centre of gravity for EU governance and decision-making. In that context, the non-euro member states, which have expressed a clear interest in joining the Eurozone might find themselves side-lined in the process. This, in turn, could not only increase Euro-skepticism in their societies, but also contribute to the decline of the EU as a political union.

For some of the non-Euro EU countries, membership in the Euro area means much more than just sharing the same currency with other countries. It symbolises belonging to a community of prosperity based on responsibility, solidarity and mutual benefit.

The 20th Eurozone member?

On 23rd May 2018, the European Commission and the European Central Bank published the latest Convergence reports, which examine the degree of sustainable economic convergence achieved in the non-Euro

Eva Maydell MEP

countries. Despite pointing out that all seven countries have made progress with regard to compliance with convergence criteria, the reports emphasise that sustainable convergence is needed for successful adoption of the euro. However, entering the Exchange Rate Mechanism II (ERM II) and consecutively the Eurozone could be a powerful convergence tool itself.

Joining the Euro club means billions of savings for the business and citizens of a country from the decrease of transaction costs, price stability, low-interest rates, as well as easier and cheaper access to finance. Before the adoption of the Euro, estimations show that between €20 and €25 billion were spent on currency exchange fees alone. A recent analysis of the Bulgarian Institute of Market Economy shows that the introduction of the Euro will save around €450 million to Bulgarian business only from reduction of transaction costs. This amount could be well invested in R&D or simply in more production, either way, contributing to the GDP growth.

On 1st June 2018, a week after the Convergence reports reaffirmed the positive macroeconomic trends in Bulgaria, Standard & Poor's raised its perspective for the credit rating from stable to positive. Those signs of optimism to investors come at the mere preparation of the country to join ERM II and will be certainly followed by more positive estimations should Bulgaria enter, which in its turn adds to the convergence efforts of the country.

The case for Bulgaria to join the club

The convergence reports of EC and ECB indicate clearly that Bulgaria is closest to joining the Eurozone as it is the only country complying with all nominal criteria – price stability, long-term interest rates and public finances. In practice, Bulgaria also matches the exchange rate stability criterion as its currency has been pegged to the Euro (and beforehand to the German Deutsche Mark) since 1997. However, in theory, any country must prove this stability for at least a two-year period in the ERM II. Joining it is a political decision and the Bulgarian government has stated it will formally apply to enter in 2018.

The Vice-President of EC for the Euro, Valdis Dombrovskis, welcomed "the Bulgarian authorities current work towards ERM II participation". With the latest Eurobarometer stats showing all-time highest more than 50% public support among the citizens of non-Euro countries for joining the single currency, the political decision to expand the Eurozone is becoming a strategic choice, which could affect the direction and outcomes of the whole debate for the future of Europe. ■

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Improving the government's accountability to the public: A view from the UK

Benoit Guerin, senior researcher at the Institute for Government, argues that better accountability for the government can deliver concrete benefits to citizens

Around 5.4 million public sector workers deliver services ranging from healthcare to transport and education to the British public every day. They are held to account by 21,000 elected officials, along with a swathe of watchdogs and inspectorates.

Judging by media coverage of failures in delivering major policies such as Universal Credit, the poor performance of companies delivering public services, and occasional tragedies like the Windrush scandal or the Grenfell fire, the public may be tempted to question the effectiveness of the UK's accountability system.

Accountability is an important component of effective government. It gives an opportunity to pass judgement on how well those in public office have delivered their responsibilities. When harm occurs to the public, a good accountability system should ensure redress. By contrast, weak accountability is associated with the increased risks of failure. This can mean financial mismanagement, the underperformance of public services, or their collapse.

Keeping tabs on government's decisions in Whitehall

The Institute for Government's recent discussion paper on accountability found that the current system of government accountability in the UK is beset by weaknesses. One consequence of this is that it can be difficult for members of the public to gain an understanding of what the government is doing.

For a start, it is far from clear to an external observer who is responsible for decisions at the top of a department. This is partly due to the close relationship between a minister and their most senior civil servant, the permanent secretary.

Take Universal Credit, for example, the government's flagship policy to reform the benefits system for those with low income or out of work. The initial phase of the programme took place at breakneck speed. According to the National Audit Office, about £300 million had already been spent – mainly on IT systems – by April 2013, shortly after the programme had to be reset after major concerns were raised. It was never clear who had decided on the initial timeline, with both the minister and civil servants pointing fingers at each other.

Public services and accountability to the public

These issues are not limited to Whitehall. With the government increasingly relying on private and voluntary contractors and arms-length bodies to deliver public services, delivery has become more complex over time.

Due to poor quality data, the government doesn't effectively scrutinise the performance and value for money of contracted-out services. This has resulted in failures – in areas ranging from the outsourced administration of benefits to the electronic tagging of offenders – which have occurred repeatedly over time and across government. In the latter case, the Ministry of Justice was overbilled millions of pounds by contractors for eight years before it spotted the issue.

Ultimately, this also affects the public, who find it difficult to know how the quality of the services they receive compares. There is little up-to-date, accurate, comparable information available, which means often, various figures are traded by politicians in debates, leading to confusion. To make matters worse, the frequent changes in policy and accountability mechanisms can make it difficult for individuals to know where to turn to seek redress when poor services are delivered, sometimes causing harm.

Finding solutions: we want to hear from you

The Institute for Government believes that this situation is not beyond remedy. Our ongoing work on accountability aims to start a conversation about how to make things better.

We have set out options for change in a recent discussion paper, which we want anyone interested in accountability to comment on. Some of these options are technical, but all ultimately aim to benefit the public by helping to deliver better public services and better government.

There are practical ways to transform the way that ministers, and Whitehall officials can be held to account. This might involve publishing the evidence used to develop policies to enable better discussions within departments or strengthening the formal accountability of officials.

In wider public services, better scrutiny is possible, either through contractors delivering public services publishing performance data, or more systematic scrutiny of the value for money of services delivered locally. ■

These are but some of the suggestions we have developed. To find out more and to contribute your own ideas, please consult our discussion paper, and contact us at accountability@instituteforgovernment.org.uk.

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Using data analytics to create new opportunities for local authorities

Steve Shirley, Vice Presudent of Public Sector at Mastercard provides insight into using data analytics to create new opportunities for local authorities

With resources and finances under constant pressure, planning and policy decisions at a local level can be difficult to make – particularly where there is a significant associated cost to justify – and sometimes reliance on anecdotal evidence and perceived public opinion as much as hard, established facts and information.

However, there is a wealth of data out there for local authorities to access and use to their advantage when making some of these important decisions. With this, cities can realise their full potential and unlock growth opportunities by having a better understanding how people and businesses behave – and more effectively target efforts aimed at maximising consumer spending, economic growth and tourism.

Data-based decision making

Vibrant cities are crucial in fostering economic growth. They are the hubs that attract and retain businesses, people and resources to their region. When decisions are made, local authorities already consider a variety of information and data sources, but often in reality, these sources can sometimes be disparate, incomplete and untimely – and lead to sub-optimal outcomes.

There are more organisations collecting data and packaging it into useful insights than ever before and authorities should make full use of these. Relevant data should inform and drive all economic decisions and that objective data can take out the guesswork about where economic investments should be made.

Mastercard developed a number of solutions for local authorities to use to their benefit that leverage the wealth of transaction and consumer spending data we have access to. Crucially, this data directly relates to what local authorities are trying to influence – spending – and its inherent relevance, as well as the insights it can generate, are invaluable.

These solutions can map out local communities and help identify where investments should be made for long-term success, whether that be identifying up-and-coming areas for targeted investments focused on urban development or improving efforts to attract visitors from overseas.

Data-driven growth opportunities

Mastercard Retail Location Insights (MRLI) can help analyse the performance of any economic area in a local community, providing interactive mapping which evaluates the sales-based performance of retail locations. MRLI integrates Mastercard's data expertise and anonymous, aggregated and secure transaction data from more than 2.2 billion cards to provide insights on revenue performance at street level.

By leveraging reliable, accurate and timely insights in the sales-based performance of retail locations this data can be used to identify opportunities that can revitalise a given city centre. By matching the right location with the right commercial application, extraordinary ripple effects in trade and business around the wider locality can be seen.

Insights like this can be used to help answer a number of questions that local authorities can use to help shape their decision making. For instance, it can help benchmark against comparable cities, identify the ideal locations for new retailers in the community and assess how retail conditions are changing.

It can also help authorities assess the impact of an economic decision over time and what can be learned from that to spur additional economic growth.

Exploring a new arena opening in an urban area can also help illustrate the advantages of some of these analytics capabilities. While it may seem obvious that a new arena opening will bring about greater spending and wider economic growth, MRLI data can delve deeper into trends and help identify where this growth comes from. For example, when a new arena opened in the US the ripple effect for the surrounding retail area was significant, with a 57% increase in retail traffic activity in the four years that followed.

As you might expect, after the arena opened, surrounding bars and night-

clubs experienced immediate growth. However, data showed that restaurant spending was much slower to grow as the restaurant formats changed to align with the new customer profile. The analytics also helped illustrate the volatility in the retail areas around the arena driven by the event schedules.

Tourism and travel

Not only do data analytics help show consumer spending trends by street and sector, they can also allow local authorities to understand their regional and even international appeal.

By utilising transaction data, solutions such as Mastercard Destination Insights, local authorities can understand the spending patterns of visitors to their areas.

This insight can be invaluable in knowing how to best target investments focused on boosting the attractiveness of areas to tourists, or even domestic visitors from further afield.

By identifying spending from those living outside the area, local authorities can much better understand their visitors, where they are from, where their areas are currently performing well and also explore areas for improvement.

For example, Destination Insights can show the seasonality of overseas spending – helping show the peak times tourists are in the area and the lengths of their stay – allowing authorities to plan events and activities to maximise dwell time and spending while visitor footfall is at its highest. It can also show where this spending happens, both in terms of location – identifying the most popular neighbourhood and areas within the region – and what sectors and spending categories are most popular with visitors. Visitors from one area may spend more on food and drink, whereas some may spend more on gifts and souvenirs to take home with them.

The breakdown of this data and knowledge of where a city's visitors come from, how they spend and what they spend on, allows local authorities to make much better and more targeted decisions aimed at specific growth opportunities they want to pursue.

For example, a city with a high concentration of bars and restaurants, which has identified that visitors from Asia tend to spend more on food and drink and identified that this trend is increasing over time may choose to target their tourism efforts at China, at a time of year where there is an extended holiday period and arrange an event like a local food and drink festival to capitalise on the high footfall from Chinese tourists, maximising spending in areas that appeal to them and that provide growth to the local economy.

Transportation

Even transport to and from an area can provide incredibly useful data and insights for local authorities. Personalisation in transportation, brought about by data collection and analysis, is an innovation just around the corner and this personalisation can help increase revenue both for authorities and business partners.

Cities are able to use advances in transit payments systems like mobile ticketing to ease passage (for example, significantly reducing boarding time), to predict the movements of passengers and use analytics based on previous transaction data to predict what they will spend while within their destination city.

This level of transit personalisation is not far off. In the UK, Mastercard helped National Express enable mobile ticketing with passengers from 10 universities in the West Midlands now able to buy monthly travel passes via mobile devices. Likewise, in the North West, mobile ticketing has been introduced across the local bus network in Preston with the aim to reduce passenger boarding time by 50% by 2020.

Truly smart transit systems will be able to alert a passenger that their train is ten minutes late and when it has been re-scheduled for (based on travel data patterns). These systems will also be able to incentivise spending during that delay period by, for example, serving a 10% discount on that passenger's favourite nearby coffee shop (based on previous spending patterns).

A clear case for data

There is a very clear case for more and better use of data by local authorities. It removes the risk of making false assumptions and allows more thoughtful, long-term planning with strategies developed on intelligent and evidence-based insights.

Authorities can learn a lot about their areas by looking into the patterns and trends identified by solutions, like those offered by Mastercard and increase the likelihood of achieving their intended outcomes by adjusting policy and plans as a result.

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Technology and flexible working patterns: Transforming the way we work

Richard Morris, UK CEO of International Workplace Group (IWG) explains how technology and flexible working patterns are transforming the way the public sector and other organisations work in the UK today

Since the Industrial Revolution, major economic and technology-driven shifts have caused significant social change. New technologies, data analytics and social networks have all had an impact on the way that people communicate, collaborate and work. As generations collide, workforces become more diverse, people are starting to take greater control over their work hours.

Businesses are beginning to appreciate that significant transformational change can offer new opportunities and that traditional workplace models could soon be a thing of the past. This article will examine the drivers transforming the world of work, as well the role of social attitudes in driving the uptake of flexible working.

The rapid acceleration of technology has changed what's possible in UK workplaces, including the public sector. Slowly but surely, the way in which we think about offices, how we work and productivity, has started to change. According to Deloitte's Mobile Consumer Survey, within two years, 80% of the world's population will own a smartphone. With the internet, cloud communications and smart devices, it's never been easier to plug in and work from anywhere. The key to successful implementation of such technologies is creating a supportive environment with plenty of communication to make everyone feel included and empowered.

This means that the effectiveness with which organisations plan people management will be critical to

Richard Morris, UK CEO of International Workplace Group

long-term viability. Ensuring you have the right people, with the right skills, in the right places is key to unlocking future growth. Think too much in the short-term and you may find yourself on the back foot, unable to catch up with sudden shifts in your marketplace.

Our clients operate across many industries, and, like all businesses today, are in fierce competition to secure the best talent. A flexible, efficient workplace can be a catalyst for change, enabling businesses to extend their reach to secure the best and brightest from anywhere in the UK. Findings from IWG's Global Business Survey found that each week, 70% of employees are working somewhere other than the office for at least one day. More than half (53%) work remotely for half of the week or more, whilst one in 10 (11%) work outside of their company's main office location five times a week.

The pace of technological change has also pushed many businesses to reassess its real estate portfolio. No longer constricted by a defined geographical area, flexible workspace enables businesses the freedom to travel to potential clients. At our firm, we ensure that clients can be brought to offices that are modern, impressive and deliver all the requirements needed for a business to operate smoothly. Top of the range IT, Wi-Fi, friendly and professional staff and catering come together to provide businesses with a seamless experience – wherever they are.

But it's more than this. Digitisation is providing new possibilities for collaboration in the workplace. Having all of your employees under one roof, having the same conversations with the same people day after day, might be stifling your business' potential to grow and develop. A more collaborative space, filled with like-minded businesses and people and build around the premise of co-working, can foster greater creativity. Businesses are increasingly recognising that more creative employees are also more productive – and that productivity is good for business.

> "The rapid acceleration of technology has changed what's possible in UK workplaces, including the public sector. Slowly but surely, the way in which we think about offices, how we work and productivity, has started to change. According to Deloitte's Mobile Consumer Survey, within two years, 80% of the world's population will own a smartphone."

There are other notable financial benefits for businesses who make their permanent base a flexible workspace. A business can move people into a new market quickly and take them out again when required. They can put their people close to their suppliers. They can do all of this without committing to long leases and expensive relocation costs.

Technology has therefore created a modern economy that has the propensity to empower more UK businesses. Whether you're an entrepreneur, start-up, small business or working for a larger corporation, an inspiring workspace will continue to nurture the next generation of forward-thinkers, innovators and game-changers. Businesses are rewarded in return with a highly motivated workforce and a healthy balance sheet. ■

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Could smart working change our urban landscapes?

Alison White of PLACEmaking considers why we should rethink our attitude to heritage buildings and if smart working can change our urban landscapes

There's a common assumption that older buildings and especially those with a heritage listing are uneconomical and difficult to use as modern workplaces. For heads of property, the burden of operating from a heritage building often results in a desire to relocate to a bright shiny glass, steel and concrete alternative. Older buildings with no heritage protection are frequently flattened, while with luck, those with protection might be offloaded onto someone else. Without luck, they are mothballed and their long-term survival becomes questionable.

But are the criteria used to appraise these buildings as contemporary workplaces actually fair? True, many will fail to measure up to the 'modern' office building specifications that have influenced workplace design since the 1980s: large open plan, air-conditioned and artificially lit spaces with raised access floors and suspended ceilings. But is it possible that our fundamental way of working, as defined by smart working, is now so changed, that these specifications are now out of pace with what we want from a workplace? If so, then it's time for a recalibration of how we regard our heritage building stock.

Firstly, consider that all buildings are made up of spaces that people can occupy and areas that they can't. An owner funds the whole building, while tenants rent agreed on spaces that typically exclude ancillary areas such as stairwells, lifts, toilets and structure.

Heritage buildings, and in particular town halls often have more of these areas, reflecting the bespoke design and use for administrative and democratic activities. Efficiency ratings are reduced by endless corridors, snaking around between individual rooms and guiding large numbers of people simultaneously accessing, assembling within and exiting chambers or conference halls. Poorly ventilated areas with no natural light are usable only as stores. When all of that gets deducted, what is left is the occupiable space and it's here where these buildings often fall short in comparison with their modern counterparts.

But what if we could squeeze down these ancillary areas? Could we then increase the available space for people to work in and therefore make these buildings more efficient? And what if we recognise that the way we work has changed by not looking to fill these spaces with rows of desks, offices and meeting rooms? Would this make more effective workplaces and would these buildings then stand up better by comparison?

If we don't want traditional office space what do we want?

Smart working enables us to use offices differently. We don't have to be at work all day, every day anymore. We can choose where we go and what facilities we want to use. If what's on offer in one space doesn't suit us, then we'll go somewhere else. Our tastes have changed too: we want characterful and quirky in place of monochrome and modular, with

greater emphasis on social and interactive space over isolated solitary offices. We want options that suit our personal tastes, not generic solutions imposed by rank or seniority. We don't want to own desks or offices, instead, we want to be consumers of highly serviced, easily operated and properly equipped facilities. If these features better describe what we need, how would heritage buildings stand up to scrutiny now? Quite well actually.

Let's look at an actual case study: Bristol's Grade 2* listed City Hall was a typical large council building built between the world wars and prominently located in the city, used for public-facing democratic activities and as an administrative HQ.

Can the building efficiency be improved?

Prior to refurbishment, only 40% of the building's administrative area was occupiable. The rest was made up of stores (14%), corridors (26%), lifts, stairs and basic toilets (26%) and structure or walls (6%). The space efficiency rating was 'Poor'.

Post-refurbishment, the occupiable area was increased to 58%, changing the space efficiency rating to 'Good/Fair'. Whilst you'd assume modern office buildings would rate as 'Excellent', that's not always the case and this rating compares well.

The improvements did not directly bring the building's efficiency rating up to speed with modern counterparts, but it did increase by 24%.

Can the effectiveness of a workplace be improved?

More tangible benefits were achieved by how much more effectively that expanded occupiable space is now used and smart working is key to that.

Pre-refurbishment the building accommodated 575 people in traditional office space.

The council initially considered a more passive open plan 'desk sharing' upgrade of their workspace. This would have increased the number of people in the building by 250, but it involved the removal of internal walls, something that is not desirable or possible in a grade 2* listed building.

The approach was rejected. It fell short of the council's strategic objectives and the capacity increase was disproportionate to the investment required and disruption caused.

Instead, a smart working solution was adopted. This better supported the service transformation and the investment in mobile technology, telephony and digital systems enabling staff to work from anywhere. Wi-Fi replaced cables and with no need for raised floors, suspended ceilings or rectangular office furniture. Many grand spaces were restored by removing 'modern' infill divisions opening up large areas as originally intended. The building capacity was increased by 1,725 and if measured by the cost per head, this was a significantly more affordable and palatable solution. The result – 30% of the building comprises shared desks, the remaining 70% is a dynamic, shared non-desk based smart working workspace matching modern expectations.

How is the building now regarded?

Although faded by prolonged lack of investment, publicly regarded as old-fashioned and hated by the office workers, the building was still largely intact with many hidden original features, artefacts and furniture. It has now been given a new lease of life; users have been wowed by its transformation into a high performing modern workplace within rooms containing restored decorative features, while greater public access has reinforced its status as an important city resource. Retained as part of Bristol's diverse urban landscape, the restoration of it instead of relocation from it sits better with contemporary attitudes to the upcycling and rejection of the throw-away attitudes of the past.

> "Smart working enables us to use offices differently. We don't have to be at work all day, every day anymore. We can choose where we go and what facilities we want to use."

Caution – changes made to Bristol's City Hall were undertaken only after careful interaction and approval from the planning authorities and English Heritage. PLACEmaking were part of an integrated design team including conservation specialist Peter Carey of Donald Insall and Alex French architects.

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Time to "include the excluded" and ensure full participation in economic growth

Bev Hurley, Chair of the Institute of Economic Development (IED) argues that now is the time to "include the excluded" and ensure their full participation in economic growth

Given the on-the-ground economic development issues that we face as a nation, with the challenge being far more complex than the stereotypical 'North-South divide' and many UK cities lagging behind their EU competitors, the opportunity – as I see it – is for the devolution agenda to enable a recasting of the growth model.

We really must face up to the situation where the majority of households living in poverty are in work, but in low paid/low-status jobs and two-thirds of UK workers produce below industry average productivity. There is a chronic low skills problem, with low employability investment and poor management within business.

Policy is focused on labour market entry – a job/any job mentality rather than access to and progression into quality jobs – and there are low levels of investment and success rates in addressing employability, infrastructure access/affordability and ill health. Income pressures disproportionately affect the socially excluded (especially BME, women and people with disabilities).

If we are to drive productivity, we must reduce dependency on the welfare state and ensure the sustainability of our public services. We need to integrate economic and social policy – skills, education, employability support, mental health, childcare; connect people to physical infrastructure assets (e.g. housing, transport); and support businesses to move up the value and productivity chain and create better quality jobs. If we could get this right it would have a massive impact on productivity and living standards.

Inclusive growth must be at the heart of all public investment. We need to ensure it leverages social, economic and financial return on investment providing quality Gross Value Added (GVA) and tackling inequalities. This is about improving outcomes through increasing access and uptake and removing barriers to participation.

Inclusive growth challenges (and opportunities) will often be at a very local level. Regional level GVA is a poor guide to social and economic welfare and does not tell us anything about how the opportunities and benefits of growth are distributed across different areas and different social or income groups. So, we need to measure the right things – such as household incomes, earnings distribution, levels of economic activity and unemployment, as well as the growth of quality employment. Importantly, we need to share what works and equally, what does not.

> "We should focus on two areas going forward: Improving productivity and quality jobs are at the heart of inclusive growth. So firstly, we need to tackle the UK's small business profile, that is the 5.3 million SMEs, 75% sole traders and 60% of employment by increasing the quality and targeting of support at key stages – at all levels, from pre-start, sustainability and growth to help ambitious companies scale."

We also need to mobilise the full force of local resources and all stakeholders to build on existing assets and opportunities, as well as developing new creative solutions – from both inside and outside. Therefore, we must include the excluded – a bottom up and top down approach is needed to build local legitimacy. Without involving those who currently have no voice, how can you understand their needs?

There needs to be a clearly defined, shared clarity of vision, but not just a strategy – the proof of the pudding will come from action – the courage to experiment, iterate, fail and learn. So, stakeholders must all be cohered

Bev Hurley, Chair of the Institute of Economic Development

to one agenda, a common narrative, how it can be achieved, with a clarity of roles and commitment to actions that will make the greatest difference. Prioritising is vital. Where is the significant unexploited potential for increasing productivity and increasing inclusion? It is not a fringe activity – inclusivity has to be mainstreamed. For example, why not mandate equality of access to all training and business support? Why not have equality of service uptake? It is all achievable.

We should focus on two areas going forward: Improving productivity and quality jobs are at the heart of inclusive growth. So firstly, we need to tackle the UK's small business profile, that is the 5.3 million SMEs, 75% sole traders and 60% of employment by increasing the quality and targeting of support at key stages – at all levels, from pre-start, sustainability and growth to help ambitious companies scale. We must have much better quality, tailored and targeted support for different stages of the journey. We need to incentivise growth training – especially management skills, commercial acumen and dealing with the biggest barriers to growth – access to markets (skills in sales, marketing, business development and procurement) and access to finance (investment readiness).

> "Inclusive growth must be at the heart of all public investment. We need to ensure it leverages social, economic and financial return on investment providing quality Gross Value Added (GVA) and tackling inequalities. This is about improving outcomes through increasing access and uptake and removing barriers to participation."

We also need investment in training for those with lower skills and other disadvantages as this offers big returns for growth and inclusion. We must develop the capacities and capabilities of individuals, families and communities to participate more fully in society and economic growth and achieve more equitable outcomes. Their voices are usually unheard, or at best mediated through others, but you have to find ways of involving them in this agenda. They are not 'hard to reach' – go where they go, and you will find them. ■

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The compelling case for investing in Swindon and Wiltshire

Paddy Bradley, Director at Swindon and Wiltshire LEP put forward the compelling case for investing in the UK's Swindon and Wiltshire

The Swindon & Wiltshire Local Enterprise Partnership (SWLEP), which has private sector board members such as QinetiQ and US life sciences firm Catalent, is working in partnership with Swindon Borough Council and Wiltshire Council on an exciting new inward investment campaign to attract new firms, targeting particular technologies focussed on the area's strongest sectors. The campaign will be created and delivered with a range of partners across government, academia and the private sector.

New transport technologies

The LEP and councils are working with the government's Accelerator Programme for Connected & Autonomous Vehicles, with a view to establishing a new test bed for this fast developing technology, bringing together the automotive industry, data management and cybersecurity expertise.

Whilst fully autonomous vehicles are likely to remain in test-bed locations, at least in the short term, we are seeing an increase on the UK's roads of alternative powertrain vehicles, particularly hybrid and full electric variants. Dyson will be adding its world-class innovation to this trend, having committed significant investment in electric vehicle developments. Recently, Dyson announced plans to build an R&D facility at its new Hullavington Airfield site, near its Malmesbury global HQ in Wiltshire. Such an ambitious programme will undoubtedly bring supply chain opportunities.

Swindon is the only metropolis outside London with two hydrogen refuelling stations, including the UK's first public access station at Honda of the UK Manufacturing. The Hydrogen Hub is an industry-led community of stakeholders from across the hydrogen and fuel cell supply chain, government, local authorities, businesses and current and potential users.

Defence applications and pharmaceuticals

The MoD has a significant presence in the Swindon and Wiltshire area. As well as being the home of the British

Army, the area hosts the Defence Science & Technology Laboratory, part of Porton Science Park. This supports private and academic sector 'spin in' of technologies to bolster the UK's military capability and aims to commercialise the MoD's extensive collection of intellectual property, which could also have non-military uses.

The Inward Investment team and MoD technology transfer arm Ploughshare is identifying key facilities and world-leading personnel that companies can utilise. This will foster collaborations across a range of industries and increase new investment at Porton. Wiltshire Council, supported by the LEP, recently opened its new Incubator Units on site and is planning phase 2 to accommodate more companies to this unique ecosystem.

Digital technology and creative industries

Swindon and Wiltshire have a wide range of national and international HQs, with digital requirements including Honda of the UK Manufacturing; Nationwide; Research Councils UK; The National Trust; The UK Space Agency; Wasdell Group and WH Smith, supported by a vibrant SME network.

The proximity to GCHQ and local vibrant business network attracts a variety of big data and cyber-related companies to this area. Sector leading universities, such as Oxford, Bristol and Bath, the latter delivering the national Institute of Coding programme, add skilled staff and R&D collaborations to this cluster. Swindon Borough Council is investing £2 million in the 1st phase of Carriage Works, a unique rail heritage building, to provide Incubation Space and units for digital and creative companies.

Overseas activity

The partners are working with the Department for International Trade, Foreign & Commonwealth Office, the China British Business Council and regional partners to showcase local expertise in new transport systems, life sciences and digital technology to stimulate inward investment and support local exporters. This links to the UK government's Industrial Strategy and two of the Grand Challenges: Future Mobility and Data. Overseas activity will particularly focus on the Americas, Asia and Pacific regions and include welcoming groups of businesses and those exhibiting at important trade events.

Swindon & Wiltshire
LOCAL ENTERPRISE PARTNERSHIP

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Managing the UK government estate more effectively and efficiently

Open Access Government charts the role of the Office of Government Property (OGP) and the Government Property Agency (GPA) in managing the UK government estate more effectively and efficiently

The Office of Government Property (OGP) supports the UK government and the wider public sector to manage their estate more effectively and efficiently. The work of OGP sets out to deliver the best possible public services and strongly supports the government's priorities by unlocking surplus land for housing and encourages the creation of public service jobs outside London, so that economic growth is supported.

The important work of OGP builds both capability and capacity in the property function across government through the leadership of the Government Property Profession. In summary, significant progress has been made since 2010, for example the size of the government estate has been reduced by over 25% and, more than £1 billion in annual costs have been saved.

It's also worth noting that the average space that a civil servant uses in government offices has dropped by 5% on the 2015–16 figure and is significantly lower than that of the private sector. OGP has also overseen the collection of no less than £3 billion worth of capital receipts from the sale of property and surplus land.

One of the OGP's delivery priorities and programmes is One Public Estate (OPE), a pioneering initiative delivered with the OGP and the Local Government Association (LGA). OPE gives technical and practical funding and support to local authorities, helping them to deliver ambitious property-focused programmes in partnership with central government and other public-sector partners, using property as an enabling tool to deliver improved services, homes and economic growth and capital receipts.

Another priority area is Asset Efficiency and Land for Housing, whereby OGP works with departments, in an effort to manage and release government property and land, to raise capital receipts, cut running costs and deliver local economic growth, including new homes and jobs.

Also, the Government Property Profession (GPP) is another priority, so in this vein, OGP seeks to improve the capability of the 4,700 professionals in the property function. This includes specific development for the 2,000 members of the government property profession, including discipline-specific networks and communities, as well as surveying and facilities management apprenticeships and providing learning and development for those in the function.

We should also outline that the OGP is the sponsoring body for the Government Property Agency (GPA),[1] launched in April 2018. OGP plays an important role in giving guidance and oversight to ensure the delivery of its policy objectives. GPA delivers professional property asset management services across central government's general-purpose estate. Added to this, it enables the delivery of Civil Service transformation, by means of programmes such as Hubs, Whitehall Campus and Smarter Working. In this vein: "OGP drives efficiency, savings and enhanced asset values through a portfolio approach to asset optimisation."[2]

> "OPE gives technical and practical funding and support to councils, helping them to deliver ambitious property-focused programmes in partnership with central government and other public-sector partners, using property as an enabling tool to deliver improved services, homes and economic growth and capital receipts."

The last word goes to Oliver Dowden, Minister for Implementation said who provides some crisp comments about the creation of the GPA, an executive agency, sponsored by the Cabinet Office.[3] "The creation of the Government Property Agency will transform the way property is managed in the general purpose central government estate, generating savings of over £1 billion over the next ten years. The Hubs programme is a catalyst for growth in city centres across the UK, helping to boost jobs and economic growth, as well as demonstrating the government's commitment to strengthening the Union and enhancing regional career paths."[4] ■

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Compliance: Reassurance in today's complex and fast- changing world

Stuart Woolgar, CEO of Global Guardians Management Ltd explains why compliance is a reassurance in today's complex and fast- changing world

The British Standards Institution (BSI) was the world's first national standards body and it has applied standards to subjects from nuclear energy to office furniture. The UK's first management systems quality standard, BS 5750, was published in 1979. It was superseded in 1987 by the ISO 9000 series of international standards and today ISO 9001 is the world's most successful standard, having been adopted by more than one million organisations in 178 countries. BSI helps organisations turn standards of best practice into habits of excellence.

However, there are still people who view standards and regulations as so much unnecessary red tape and think bureaucracy is a stifling aspect of today's life. Nevertheless, compliance to standards, regulations and ethical practices is critical as a demonstration to its publics that an organisation is conducting itself correctly. These standards and regulations, particularly where they relate to health and safety, literally do save people's lives and should never be dismissed as petty or irrelevant.

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 BSI with the input of industry experts, government bodies and professional or trade associations.

Compliance is particularly strict in the financial sector, but standards in the built environment also need to be rigorously adhered to, especially where health and safety are concerned. Those operating in the property sector need to adhere to a whole raft of legislation and regulation and follow standards laid out in various Codes of Practice.

The Growth in the Public Estate's Vacant Property Portfolio

Public organisations such as Health or Local Authorities, as well as Government Departments, are gradually vacating property and land assets that have become surplus and this has led to an increasing number of buildings standing empty while their future is debated.

Vacant property can be a magnet for a host of problems and unexpected costs. If a building looks empty or neglected, it's an open invitation to trouble - from squatters, flytippers, criminals, drug dealers, even homeless people simply looking for somewhere more sheltered to spend the night. 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 guards or the police arrive. Determined thieves will target anything with a scrap value and this can cause considerable damage to a property. Security guards and dogs generally can't be there 24/7, the budget for that is simply impractical.

In tandem with all of this is the cost of business rates and insurance cover. Although some public and local authority property is exempt from rates, not all is, so this is still a cost to be borne even if the building is vacant. The Government primarily operates a policy of self-insurance for their property or assets, but there are circumstances where cover needs to be in place and some local authorities do have insurance policies. It is worth remembering if any third party visits or trespasses into a vacant building and suffers a mishap, the property owner is still liable.

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. In one fell swoop, the building becomes secured, the guardian company maintains it, 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.

Case study

A five-storey office building in Camden, London, had been vacated by staff from the local NHS Trust. Consequently, the trust started to experience issues with squatters who broke into the property on several occasions.

Global Guardians Management attended the site within hours of being called out and following urgent checks on the building, had vetted guardians move in straight away. This immediately prevented squatters from returning and deterred further anti-social behaviour for the 18 months they protected the property until it was handed back to new tenants.

Due to the property guardians living in the building, the trust saved over £50,000 on empty building rates and some £120,000 on security costs.

These savings enabled them to spend their budget on functional properties for nurses and medical equipment, rather than on protecting a surplus building through costly traditional security methods which had not been working.

Compliance to Health and Safety Standards and the Industry Code of Practice

One point is absolutely critical when installing property guardians to secure a vacant property. 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 reputable organisations. By complying to BS 8584, 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 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, e.g. 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 to carry out a full risk assessment, including inspection of all security, fire, and health and safety implications by accredited professionals. 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 BS 8584, together with a new industry standard Code of Practice which is currently being drafted. We are also liaising 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 who wishes to demonstrate best practice in their work, now seeks us out as a partner in the knowledge that we strive for excellence, and compliance in all areas is our mantra.

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Mid-sized cities: The key to inclusive growth in the UK

Cllr Peter Box, Chair of Key Cities takes the stance that mid-sized cities are key to inclusive growth in the UK

The UK faces a number of demanding economic challenges over the next decade. Stagnant productivity growth, unaffordable housing, inequality between regions and ageing infrastructure must all be addressed while continuing to navigate the unsteady waters of a post-referendum UK.

Any successful response to these challenges is dependent on a united country, with cities – beyond our major population centres – that can provide the skills, investment and opportunity to reinvigorate Britain's economy. There is no shortage of innovation and dynamism across these cities but for such resources to be effectively tapped, decision-making must be brought as close as possible to people and businesses across Britain.

> "Addressing underinvestment in key sectors, inadequate housing, limited infrastructure and poor skills in these cities, is a vital step towards inclusive growth. It is also important that their unique strengths, such as their greater agility and capacity to focus on very specific areas of competitive advantage, can be deployed, and the barriers to seizing opportunities removed."

That's why during the summer of 2013, we officially brought together the Key Cities Group, a cross-party initiative comprising 20 of the UK's cities middle-sized cities. For Key Cities, policy and delivery must be more integrated and tailored to the diverse needs of the country, particularly given growing evidence that smaller cities often play a highly significant role in driving a nation's economic performance.

Our mid-sized cities, ranging in population from approximately 100,000 to 700,000, deliver a Gross Value Added (GVA) of £133 billion to the UK economy (equivalent to the GVA of Scotland) and play a key role in their regional economy: some are centres of innovation, some are centres for production, whilst others may be the focus for trade. There is a wealth of opportunity that will only truly flourish once longstanding issues of economic imbalance and exclusion are addressed and they are equipped with the tools to attract inward investment.

Image: © Matthew Page Photography

Cllr Peter Box, Chair of Key Cities

Unblocking barriers to productivity

Indeed, these cities, which include some of the poorest and most economically challenging parts of the UK and voted overwhelmingly for Leave in the referendum, represent a vital conduit through which national policymakers can hear from and reach the heartlands


Coventry in The West Midlands, England

of Brexit Britain. With the necessary voice, the councils of these cities can play a central role in connecting Leave voters with the big decisions on the economy and wider society from which those voters have clearly felt so alienated.

For a country that now lags 26% behind the United States and 15% behind the average of G7 countries, it is essential that we ensure the development of policy and practice that enables all cities to identify and unblock barriers to higher productivity. A number of our mid-sized cities are already performing well across industries from digital to advanced manufacturing, but strong productivity and associated measures are far from being universal across mid-size cities in the UK.

The key to an inclusive country

Addressing underinvestment in key sectors, inadequate housing, limited infrastructure and poor skills in these cities, is a vital step towards inclusive growth. It is also important that their unique strengths, such as their greater agility and capacity to focus on very specific areas of competitive advantage, can be deployed, and the barriers to seizing opportunities removed. This in part, requires Key City councils to deepen democratic engagement within their own places but also having the necessary freedoms, powers and resources to make that democratic engagement meaningful.

A united, productive and inclusive future for the UK cannot be achieved without these key cities. The size of their collective populations, importance to the economy and high concentration of Leave voters means they must be at the heart of any effort to deliver change.

The attributes of these cities are by no means uniform, but the diverse nature of the individual cities' heritage and assets, when brought together, offers a significant combined presence. The UK works best when it works together, and Key Cities will continue to create a unified voice and an alliance of shared interests that can ultimately meet the UK's biggest challenges. ■

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Dealing with diversity **in European cities**

Dr Gideon Bolt from Utrecht University explores the compelling subject of diversity in European cities and how this is dealt with today...

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Utrecht University

The role of housing allocation in the decline of high rise housing estates

Dr Gideon Bolt from the Department of Human Geography and Planning, Faculty of Geosciences at Utrecht University tells us about the vital role of housing allocation in the decline of high rise housing estates

In a contribution to the previous issue of Open Access Government, I discussed the planning failures that played a role in the deterioration of large housing estates (Bolt, 2018). These failures included a bad physical quality of the buildings, the selection of unsuitable locations and an urban design that led to social problems.

In the epilogue, I acknowledged that not all housing estates have the same problems and that planning factors are usually not the most important explanation for the decline of estates. Other factors include housing allocation policies and exogenous factors like housing policy and economic restructuring. In the next issue, I will dwell upon the latter factor; but in this issue, my focus is on housing allocation.

Recruitment of the first residents

While most high-rise housing estates did function quite well in the first years after their completion, some estates had to struggle with a negative stigma from the beginning, due to a high poverty level among the initial population. An example of a neighbourhood with a spoiled reputation from the beginning is Park Hill in Sheffield, which became to be seen as the ghetto of a suppressed underclass due to the allocation policy of the municipality (Monclús & Díez Medina, 2016).

Gorbals, in Glasgow, was another high-rise estate that was built in the late 1950s. It replaced a disreputable slum area and due to the stigma, that was already attached to the area and the composition of the population (many former slum inhabitants), Gorbals could not get rid of its disreputable reputation. Hence, path dependence seems to play a role in the life cycle of a neighbourhood. Once a bad reputation of a neighbourhood takes on fixed forms, rather early in the course of its history, it is very hard to get rid of that stigma (Hastings and Dean, 2002).

In the former communist countries, the initial population of housing estates had a different socio-economic profile. While housing estates in Western Europe were mainly inhabited by blue-collar workers, housing estates in Eastern Europe were dominated by the middle class. In Hungary, for instance, there was much less equality in housing allocation than what might be expected from a communist state. Bureaucrats, intellectuals, the military and workers in high-priority sectors, were over-represented in the state-built housing estates, whilst members of the working class often had to rely on the self-build housing sector (Kovacs & Herfert, 2012). This allocation policy led to a spatial division between the cities and their hinterland, with a much stronger presence of people with a high level of education and income in the former than in the latter.

> "The circle starts with signs of physical decay that may cause difficulties with letting. In order to avoid vacancies, this can lead to the acceptance by housing officers of the more vulnerable households, which, in turn, may even worsen the image."

In Leipzig-Grünau, people from the hinterland were moved into this urban housing estate as they had to make way for brown coal mining. They ended up in the most recently built complexes and (partly) as a consequence of that, the status of these complexes was lower than that of the older complexes, where the initial population had a higher level of education (Grossmann et al., 2017).

Changes in housing allocation

Most housing estates in Western Europe initially had a good reputation. The poorest households and those who were deemed to be less deserving, were actively excluded through tests of the ability to pay and appropriate social behaviour (Kenneth and Forrest (2003). In the course of time, however, the social profile of incoming tenants started to change in many cases. The timing of the social degradation is very much dependent on the

regional housing context. Problems started in the 20-story John Russell Court block in Edinburgh only five or 10 years after the opening in 1964 when problem families were moved in, which quickly led to the deterioration of the image of the estate (Hall, 2014). The reason for this change in allocation policy was the high level of housing production leading to an unexpected housing surplus after 1968.

Anne Power (1997) links the housing allocation policies at large housing estates to the bad physical conditions (as a consequence of a combination of a low initial quality and a lack of maintenance). She describes the problems of large housing estates as a vicious circle of design, lettings and social difficulties. The circle starts with signs of physical decay that may cause difficulties with letting. In order to avoid vacancies, this can lead to the acceptance by housing officers of the more vulnerable households, which, in turn, may even worsen the image. A concentration of these kinds of households may make social problems more complex (Power, 1997).

As explained above, the housing allocation process was completely different in Eastern Europe. After the transition, the differences in social status between more and less desirable locations have increased (Kovacs & Herfert, 2012). Whereas the transition in post-socialist cities was in most cases characterised by a massive privatisation, the changes in the former German Democratic Republic (GDR) were less drastic. In the large housing estate Grünau, in Leipzig, only the younger parts have been privatised, while older parts are still in the hands of the same housing cooperatives and municipal companies that first built them in the 1970s.

In contrast to most large housing estates in Western Europe, it is the private companies who attract low-income and welfare-dependent household in order to avoid vacancies. The social economic profile of the older, social rented, part is much more stable and mixed (Grossmann et al., 2017). This illustrates that the concentration of social housing is not necessarily the main reason that housing estates are deteriorating. In the next issue, I will explain that the declining reputation of social housing estates is not a natural phenomenon, but the result of a deliberate choice that favours homeownership at the expense of investments in the social housing sector.

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How smart cities can learn from the model of targeting gaps in public services

Hannah Kaner, Smart Cities Strategist at Orange Bus explains how smart cities can learn from the Uber model of targeting gaps in public services

In 2015, Uber reinvented the bus. Almost. The company experimented with UberHop in Seattle; cars would collect travellers who connected through the app at planned fixed pickup and drop off points during commuting hours, so from there they could all walk to work.

The service wasn't a clear success. It was cancelled in 2016 because users were not opting for smaller, pricier vehicles over public buses. However, Lyft, Uber's competitor, learned from the experiment and offered a larger shuttle service in San Francisco. Both companies detected and exploited a gap between public service and citizen expectations and developed a solution from which they could profit.

This is a benign example of a trend where citizens turn to private companies to compensate for failings of traditionally public services. In this case, the intervention is not as dangerous as, for example, citizens in the UK and USA turning to Uber instead of ambulances for emergency transport, due to long waits or high bills. No wonder 'I'll uber it' is becoming as ubiquitous a verb as 'I'll google it'.

The appeal of the Uber model, despite its flaws, is that it puts users in a position of power, it positions citizens as active and capable managers of their own satisfaction. Effectively eliminating or automating central admin tasks, while making both drivers and customers feel safer. Furthermore, the company uses information gathered through their product, as well as colloquial or anecdotal evidence from cities to identify gaps and opportunities for innovation.

Smart cities and governments in development have at least three things to learn from this approach: to effectively gather information around user dissatisfaction with public services before private companies can capitalise on city functions; to use a combination of systems data and localised information to create effective, targeted innovations or interventions; finally, to develop an internal innovations model that sees citizens as active managers of their own civic life, therefore, not investing in wholescale automation, but understanding exactly where and when an automated service will increase engagement and where and when a more flexible and personalised approach is required to enable a clear view of rewards, support and accountability.

That's easier said than done. Local authorities cannot yet afford to innovate fast and fail fast, as Uber can; while the company's targets are fairly affluent citizens with disposable income, cities need to support the less able to support themselves. However, it is better to develop an appropriately paced approach to innovation, rather than not innovating and still failing, slowly and painfully.

An effective model is to use an innovation framework to turn business cases in the city into use cases for its citizens. Identifying problem gaps and developing or acquiring the right tools to address them.

Transport for London is trialling demand-driven bus routes in coordination with the data analysed by Citymapper. Taking a user-first approach to addressing data information, they are tailoring routes to user need in real time rather than the more traditional approach of expecting user behaviour to adapt to outdated infrastructure and old bus routes. This takes the demand-response aspect of Uber and approaches it with an inclusive smart cities system that supports individual users. With further, qualitative research to include area users who aren't using Citymapper

"Transport for London is trialling demand-driven bus routes in coordination with the data analysed by Citymapper. Taking a user-first approach to addressing data information, they are tailoring routes to user need in real time rather than the more traditional approach of expecting user behaviour to adapt to outdated infrastructure and old bus routes."

through smartphones, TfL will have invested in a smart approach for resilient public transport services.

While Oxford City Council is trialling infrastructural changes and smart traffic light management systems to address the shortfalls of ambulance wait times, the GoodSAM app provides a more targeted approach. The service connects local medics to local emergencies in real time and compensates for the same problem of traffic preventing inner-city ambulances arriving at emergencies on time. Both solutions compensate for service failures and city congestion and both are examples of the kind of tailored solutions local authorities should invest in developing.

Local authorities have the data, technology and opportunity to create and manage demand-based models of engagement and intervention like these and change the way their services are delivered. With effective digital partnerships prioritising research-driven and targeted intervention, local authorities could provide cost-efficient and effective services that empower citizens to make their own choices. Further, services driven by research, innovation and validation will address needs with targeted use cases that support rather than rather than undermine public services. ■

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inspirerar.

The City of Varberg:

The City of Varberg profile their attractive and exceptional city based in the south-west coast region of Sweden

Varberg is an attractive community, based in the south-west coast region of Sweden, with a long history of growth. In fact, 2017 marked the year where the municipality experienced 60 years of continuous population growth, which is quite unique in a Swedish context. Only 14 municipalities in Sweden have achieved this.

The city of Varberg is ideally located in the historic city centre, right next to the coastline and boasts a rich and diverse countryside. Our location is exceptional - right in between two of Sweden's fastest-growing regions, The Greater Gothenburg region and the Greater Copenhagen region. The Swedish Government is investing heavily in the west coast railway to increase the capacity for commuting and to connect cities and regions along the way. In Varberg, this means our section of the railway will be in a tunnel under the city centre. To make the most of this, we will move parts of our harbour and have already begun planning for a new waterfront area that connects the city centre with the coastline, which will remove any industrial barriers.

In the 1950s, Varberg was "discovered" by people in Sweden's bigger and more industrial cities. This, of course, coincided with the larger availability of cars to a greater number of people. Before that, the towns along the south-west coast of Sweden were mostly dependent on the fishing and farming industries, but suddenly the tourist sector exploded when the demand for city people to take a summer holiday on the coast increased. Varberg is one of the cities that has really flourished because of this development, whereas others flourished for a while and then slowly went into a quiet slumber.

A hidden gem in Sweden

That Varberg is different from other communities is obvious in so many ways. It can largely be attributed because there is a high level of entrepreneurship here, indeed there is a very diverse business sector in the municipality. This ranges from the large-scale industrial production of timber, pulp and energy, to countless hotels and restaurants that serve Varberg as one of Sweden's most popular spa and coast resorts – all year round. Varberg is in many ways a hidden gem, but more and more people discover the city as a place to settle down. It's less than an hour away by car or train to Sweden's second largest city (Gothenburg) and the airport of Landvetter, Varberg is well connected.

Varberg is really making the best of its fortuitous position today. The building boom in Sweden is also apparent here, indeed new residential areas are the results of wise planning for developing former industrial properties and using fill in sites to make the city more interesting for everyday life.

Although most of the development for housing is focused on the city, we strive to involve residents living in our more rural communities too. We engage people in the decisions that have the greatest effect on their everyday life. Through dialogue and local action plans, we work together to see where public and commercial service, infrastructure and housing will come to best use. It is also a way for our citizens to meet with local politicians and decision-makers and share their thoughts about how the municipality can be made even more attractive.

A sustainable society needs to be based on people empowerment and the foundations of democracy. New forms of meetings are important for reinventing the community. Our aim is clear, and we are acting on it. We are building a community converging around means of public transportation and a sustainable lifestyle.

Increasing Europe's energy security

The work of Miguel Arias Cañete, European Commissioner for Climate Action & Energy is placed under the spotlight by Open Access Government, with a focus on his priorities for the energy sector

Miguel Arias Cañete, European Commissioner for Climate Action & Energy has held this position since 2014, since which time he has been responsible for increasing Europe's energy security, among other things. This responsibility can be achieved by, "diversifying sources of energy imports and uniting Europe's negotiating power in talks with non-EU countries", according to his official website.[1]

His other important responsibilities concern selecting energy infrastructure projects to help establish a European Energy Union, developing an EU policy for renewable energy so that the EU can become the world leader in this area – plus strengthening the Emissions Trading System, the EU's flagship climate policy. We must not forget the Commissioner's role in proposing new EU laws to implement the 2030 climate and energy framework, as well as navigating negotiations with the European Parliament and national governments in this vein.

EU budget: Plans for funding on the environment and climate action

On 1st June this year, we learn that for the next long-term EU budget 2021-2027, the European Commission plans to increase funding by almost 60% for LIFE, the EU programme for the environment and climate action which was discussed in a recent Open Access Government interview with Catherine Bearder MEP.[2]

We know that LIFE programme is one of the EU funding programmes for which the European Commission plans the largest proportional increase, with a budget of €5.45 billion from 2021 to 2027. The European Commission has incorporated climate action into all key EU spending programmes, especially cohesion policy, regional development, research and innovation, the Common Agricultural Policy, energy, transport, as well as the EU's development policy. To implement the Paris Agreement and the commitment to the United Nations Sustainable Development Goals, the Commission proposes to increase the level of ambition for climate financing across all EU programmes, with at least 25% of expenditure contributing to climate objectives.

Concerning this, Climate Action and Energy Commissioner Miguel Arias Cañete says: "A stronger LIFE programme will play an important role in expanding investments in climate action and clean energy across Europe. By continuing to support climate change mitigation and adaptation, LIFE will also continue to help the EU deliver on its climate goals and commitments under the Paris Agreement and the United Nations Sustainable Development Goals."

> "Our ambitious commitment to clean energy in Europe and the Paris Agreement will be made a reality by laws like the one voted today: the revised buildings directive will help create local jobs, save consumers money and improve Europeans' quality of life."

One of the main features of the new LIFE programme is an increased focus on clean energy, indeed, one of the main aims is to encourage investment and support activities towards energy efficiency, particularly in European regions which are behind and need to catch up in the transition towards clean energy. Of course, the next step is that a swift agreement will be reached on the overall long-term EU budget and its sectoral proposals, to ensure that EU funds begin to deliver concrete results as soon as possible.

Agenda for safe, clean and connected mobility

In May this year, we discover that the Juncker Commission is carrying out the third and final set of actions to modernise Europe's transport system. The aim of this policy is that all Europeans can benefit from less pol-

Image: © European Union, 2017

Miguel Arias Cañete, European Commissioner for Climate Action & Energy

luting vehicles, safer traffic and more advanced technological solutions, while also offering support to the competitiveness of the EU industry. In this vein, initiatives will include an integrated policy for the future of road safety; a strategic action plan for the manufacturing and development of batteries; the first CO_2 standards for heavy-duty vehicles; and a forward-looking strategy on connected and automated mobility.

Commissioner for Climate Action and Energy, Miguel Arias Cañete comments on this agenda: "All sectors must contribute to meet our climate commitments under the Paris Agreement. That's why, for the first time ever, we are proposing EU standards to increase fuel efficiency and reduce emissions from new heavy-duty vehicles. These standards represent an opportunity for European industry to consolidate its current leadership position on innovative technologies."[3]

The statistical treatment of Energy Performance Contracts

Also, in May 2018, Eurostat[4] and the European Investment Bank (EIB) launched a new Practitioner's Guide on the Statistical Treatment of Energy Performance Contracts.[5]

Miguel Arias Cañete, Commissioner for Climate Action and Energy explains his own thoughts on this initiative: "Thanks to the revised guidance published…it will be easier for schools, hospitals, and other public buildings – which make up more than 10% of the overall EU building stock – to invest for the purpose of improving energy efficiency. Energy efficiency measures are also an important means to combat energy poverty, which this Commission aims at tackling at the roots."

The energy performance of buildings

In closing, it's worth taking a brief look at new rules announced in April to make buildings more energy efficient and smarter. On 17th April, the European Parliament gave its final approval on the revised Energy Performance of Buildings directive which is a key element of one of the Juncker Commission's priorities for, "a resilient Energy Union and a forward-looking climate change policy".

The comments made on this by Commissioner for Climate Action and Energy, Miguel Arias Cañete convey a strong sense of optimism in terms of delivering this important aspect of European Commission policy, for clean energy and to save money for consumers.

"Our ambitious commitment to clean energy in Europe and the Paris Agreement will be made a reality by laws like the one voted today: the revised buildings directive will help create local jobs, save consumers money and improve Europeans' quality of life. It will also help combat energy poverty by reducing the energy bills of older buildings which will be renovated. I now call on the European Parliament and the Council to show leadership and complete the rest of the proposals of the Clean Energy for All Europeans Package."[6] ■

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Adaptation in cities

The art of lateral thinking

Apl Prof. Dr Steffen Bender and Dr Markus Groth from Climate Service Centre Germany (GERICS) reveal their thoughts on how to succeed in climate adaptation at the city level, including the art of lateral thinking where this is concerned.

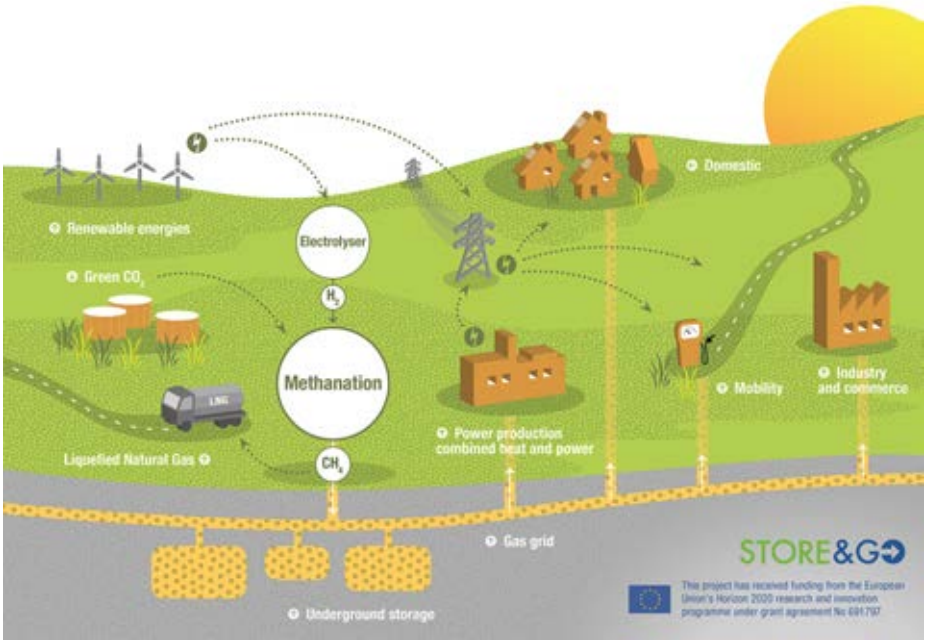
Helmholtz-Zentrum Geesthacht
Centre for Materials and Coastal Research

GERICS
Climate Service Center Germany
An institution of Helmholtz-Zentrum Geesthacht

Power-to-gas: A key enabler for a CO_2-neutral energy system

Dr Frank Graf from DVGW Research Centre at Engler-Bunte-Institute of Karlsruhe Institute of Technology (KIT) details precisely why power-to-gas is a key enabler for a CO_2-neutral energy system

"Climate change is the biggest market failure the world has ever seen", stated Nicholas Stern as far back as 2006[1]. Back then, the former World Bank Chief Economist and Advisor to the UK government identified three main setting screws for climate protection: a price for the emission of carbon dioxide, no barriers to a more efficient use of energy, and innovations for the use of low-carbon dioxide technologies.



To this day, Stern's statement remains valid – particularly in view of the ambitious climate protection goals the world has imposed itself. 195 countries have signed the Paris climate agreement that aims at reducing CO_2 emissions by at least 40% by 2030 compared to 1990, and by 80-95% by the year 2050.

For the European Union to meet the assigned target, energy production must come mainly from renewable sources. However, wind and solar power tend to be volatile and intermittent due to its seasonal nature. At times, renewable energy supply will surpass demand – for instance, during sunny summer months – and vice versa. Energy has to, therefore, be storable in the long term and available when needed.

This is exactly where the EU project STORE&GO comes into play. 27 European partners investigate the possibilities of power-to-gas (PtG) applications in the European energy grid as an important step in the energy transition. STORE&GO assumes that Europe can reduce its carbon footprint and – at the same time – cover large parts of its future energy demand only by making the most efficient use of renewable energies.

However, the integration of growing amounts of renewable sources poses technological difficulties. Even though battery arrays are becoming more powerful and price-efficient, and thus, more relevant to help to stabilise the electrical grid, they might not be able to face the growing number of renewable energy sources. Long-term and large-scale storage demands for higher energy density, lower costs and less self-discharging. One important alternative is PtG, because it allows for storing power by creating synthetic natural gas (SNG).

In PtG systems, electricity from preferably renewable sources is used to split water into hydrogen and oxygen. While the oxygen can simply be released into the atmosphere, the hydrogen is combined with carbon dioxide (CO_2) and converted to methane (CH_4), which is basically SNG. This can then be stored easily in the existing gas grid and transported to various applications, whenever and wherever it is needed: for the generation of electricity or heat, or as

One of STORE&GO's three demo sites: Methanation demo plant in Falkenhagen, Germany, with the rounded methanation reactor at the centre (© Uniper)

fuel for vehicles or ships. PtG thereby facilitates the coupling of different energy sectors.

Generating gas from renewable electrical power using PtG processes is by far the most promising way to store large amounts of energy. It also diminishes the need and costs for expanding the electricity grid.

Funded under Horizon 2020 and coordinated by the DVGW (German abbreviation for German Technical and Scientific Association for Gas and Water), STORE&GO is currently supporting three pilot plants with different innovative power-to-gas technologies: in Falkenhagen, Germany; in Solothurn, Switzerland; and in Troia, Italy.

The three demo sites provide highly diverse testing environments in terms of climate, grid type and topology, transmission and distribution grids, a combination of energy sources and CO_2 sources. STORE&GO testing works also aim at reducing energy losses and costs associated with the existing methods of converting energy. The overall goal is to create the best possible synergy effects for each location.

All three pilot plants will be powered from the regular electricity grid and at least two of them will make efficient use of the dissipated heat. At two sites, produced methane will be injected directly into the existing gas grid, while the third installation is going to liquefy methane to synthetic LNG (liquefied natural gas) to carry de-fossilisation also into remote off-grid locations.

Furthermore, STORE&GO partners are analysing the existing regulatory and legislative framework, to identify where PtG fits into the future European energy system. The researchers are also conducting a multi-country survey to identify the acceptance of the public in relation to PtG. The project partners hope to be able to accelerate the market uptake by identifying current and future business cases and models.

Based on the findings, a European PtG roadmap will be developed as an essential outcome of the project. It will contain recommendations for political decision-makers regarding which role PtG may play in the energy system in the short-, mid- and long-term. This European roadmap will also serve as a guideline for industry and research institutions to follow up with their efforts to further develop and implement the PtG technology in the future European energy system.

All in all, STORE&GO is an essential piece of the European puzzle of climate protection and the achievement of the Paris targets. Details about the demo sites and first results from cross-cutting activities will be presented in future editions of Open Access Government.

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The importance of protecting the UK's environment post-Brexit

Keith Taylor MEP, Green Party Member from the European Parliament for the South East region, shares with us his thoughts on the importance of protecting the UK's environment post-Brexit, including air pollution

"Laws without enforcement is really just good advice," Abraham Lincoln is once believed to have said.[1] In other words, 'good advice' alone is meaningless when it comes from lawmakers who refuse to put it into action.

It's a truism that has survived the test of time and, as Britain approaches Brexit, one which takes on extra meaning.

Despite the government's claim that the EU Withdrawal Bill would be the legislative means by which it transferred the full body of EU law on to the UK statute books[2] post-Brexit, it, instead, neglects key protections[3] offered by EU membership.

Not included in the bill are some of the vital tenets of EU law; the precautionary and polluter pays principles. Together they act as a robust legal backstop against the destruction of our environment.

Based on the recognition that the environment is unowned, the precautionary principle[4] forces developers and those who may do it harm, to prove, in law, that their plans will not damage the environment.

The polluter pays principle,[5] meanwhile, ensures that preventative action should be taken to avert environmental damage and where that fails the cost burden for clearing up pollution falls on those responsible for creating it.

Moreover, there is no provision for an independent watchdog to replace the enforcement powers of European Commission (EC) and European Court of Justice (ECJ) which have the legal might to take the UK government to court should it fail to live up to its responsibilities.

These are powers the EC was forced to exercise when, during May 2018, it announced it was referring Britain to the ECJ for consistently breaching EU legal limits on toxic air.[6]

Air pollution is a public health crisis linked to the premature deaths of more than 40,000 Brits every year;[7] the UK has been in breach of EU air pollution limits for almost a decade.

The EC's announcement came just days after the Environment Secretary, Michael Gove, unveiled his plans for a so-called post-Brexit 'environment watchdog'[8] that would have no legal enforcement powers.

Less an effective watchdog, critics have pointed out[9] the proposed body would see the government to escape the kind of scrutiny and accountability currently ensured by the EC and ECJ.

Despite the overwhelming majority of British citizens, leave and remain voters alike, being clear that they don't want to see Brexit exploited as a chance to erode vital environmental protections,[10] the government has indicated its desire to do just that.

The enforcement agency conceived by Gove would have neither the power to take the government nor corporations to court nor issue fines or sanctions.

Greens, environmental NGOs, conservation charities, the UN, and the British public have been vocal in their criticism of the proposals.[11] At the same time, in the House of Lords, the Conservative Government has been defeated by Peers no less than fifteen times on the EU Withdrawal Bill.[12]

One of the amendments peers passed calls on ministers

to give a post-Brexit environment watchdog some real teeth to ensure that "the rights, powers, liabilities, obligations, restrictions, remedies and procedures that contribute to the protection and improvement of the environment" are not reduced.

It was nothing less than a clear rejection of the government's watchdog proposals – that would inconvenience neither ministers nor big corporations.

For the sake of the health of our environment post-Brexit, it now falls on MPs to ensure that when the EU Withdrawal Bill returns to the House of Commons, they support the Lords' amendment.

MPs must not be cowed nor intimidated by lobbyists nor the press, they must have the courage to vote in the best interests of the British people, Britain and her environment.

Again, as Abraham Lincoln said,[13] 'you cannot escape the responsibility of tomorrow by evading it today." ■

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Climate change: Learning how to negotiate on behalf of the planet

Johanna Bocklet, Research Associate at the Institute of Energy Economics, University of Cologne shares her views on climate change, focussing on learning how to negotiate on behalf of the planet

Many of today's business students – our next-generation business leaders – feel a sense of outrage about climate change and the lack of urgency in this arena.

What some may not fully grasp, however, is just how slow progress can be, reaching a multi-stakeholder agreement to move towards a more permanent solution for a sustainable future.

Youthful idealism can quickly evolve into frustration and even disillusionment when making the transition from academia to the world of work.

So how can we better prepare them for the complexity of real-world dynamics? How can we build the leadership and negotiating skills, as well as the knowledge, to equip them to drive a better future for us all?

CEMS has found an interesting approach to all of this. In May this year, 150 Master in Management students from nine CEMS business schools came together in Barcelona. This gathering was the culmination of the CEMS Model UNFCCC programme, a series of lectures and seminars covering key concepts and literature on climate change. The Barcelona event is the centrepiece of this programme: a full-scale simulation of the COP23 climate change negotiations, in which each student plays the role of government, non-government or industry representatives. And the impact on students has been really powerful.

Simulating COP23: Three critical learning outcomes

First, there's the learning itself. Taking on the role of negotiator lights a fire that simply doesn't happen when students write a paper or give a presentation. You see them come alive as they bring their arguments to life. While knowledge gleaned in the conventional classroom context can fade over time, building real passion and this kind of intrinsic motivation embeds the learning differently – implanting a more visceral commitment to leading business into a low-carbon future. Then there's the deepened understanding.

Before the simulation, students sometimes argue that the failure of the Paris Agreement is down to unambitious NDCs or the non-binding nature of the accord itself. But they often fail to appreciate the sheer complexity of reaching an agreement with so many diverse interests at play. The simulation provides a kind of realism: it helps young leaders to understand that their ideas and interests are not the only ones in the room. They experience the reality that leading change in a business environment requires you to see the bigger picture, to listen to others and to develop the skill of patience.

"Many of today's business students – our next-generation business leaders – feel a sense of outrage about climate change and the lack of urgency in this arena."

It is important for young leaders to understand that there are no simple solutions. And that change can only be led by leaders with the empathy and the perseverance to see it through. If the Paris Agreement is built on vaguely phrased accord and is non-binding in nature, it is still a remarkable achievement in finding some common ground across so many diverse players. So, the role play exposes students to the heterogeneity of culture and the economic backgrounds at work in these negotiations.

And thirdly, students learn about integrity. In today's business environment, leaders might want to talk about

climate change, but they often still run from one plane flight to another, jetting around the world to meetings. It's hard to escape some measure of hypocrisy in the failure to walk the talk.

The CEMS Model UNFCCC simulation called for every participant to mitigate the impact on the climate, financially supporting train travel to Barcelona. Something we were all asked to consider was how to stick to a CO_2 emissions baseline – during the simulation and after. Sticking to climate change commitment in a complex working environment calls for strong personalities and sustained integrity. And it calls for an embedded commitment to responsible leadership – leadership that needs to come from every single one of us. This is also a key learning for business students. That leadership can be found everywhere.

The role for business of climate change

The climate problem has been traditionally framed as a global policy challenge.

But in these turbulent times where international relations are prone to complexity and uncertainty, it seems likely that policy on its own cannot solve the problem. Businesses will play an important role in leading the transformation towards a low-carbon world because they have the capability and resources to innovate and develop new solutions.

Of course, this transition won't be simple. It will take strong leaders – leaders with the courage to implement changes. These changes might well be extremely costly in the short term and the benefits may well only become apparent in the longer term.

Business education has a key responsibility here to help the leaders of the future develop the knowledge, the commitment, the fortitude and the resilience to be the winds of change. Not just for business, but for our people, our societies and our planet. ■

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CEMS is a global alliance of 31 leading business schools, 72 multinational companies and seven NGOs that together offer the CEMS Master's in International Management (MIM).

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How climate change impacts the energy sector in Europe

Climate Service Center Germany (GERICS) explores the degree to which climate change impacts the energy sector in Europe

The challenge to guarantee energy supply long-term is central for today's energy sector in Europe. With climate change, this challenge is taking on a new dimension. To reduce greenhouse gas emissions, major efforts are underway to shift to renewable and clean energy sources. Many of these new energy sources, such as wind power or solar power are highly dependent on the weather. To be able to assess and secure long-term energy production and distribution, changes in the climate and the related impacts have to be considered when evaluating the potential for energy generation in different regions. This includes, for example, regional assessments of wind speed trends and the expected change in the intensity of solar radiation, a comparison of the future energy demands, along with the projections for wind and solar energy generation, or examining the impact of extreme weather, such as freezing rain, on transmission lines and other aspects of energy infrastructure.

Energy suppliers and transmission system operators are becoming more and more experienced with handling short-term weather data, especially to estimate the upcoming, immediate demand and to determine the best energy mix to meet this demand. For medium- to long-term planning purposes, a look beyond the weather forecast of a few days, at seasonal forecasts and climate projections, can help avoid unpleasant surprises. However, there are a number of different factors that play a role to appropriately account for the regional impacts of climate change. Since energy companies focus on energy production or distribution as their core business, there is only rarely time or resources left to assess climate change in detail.

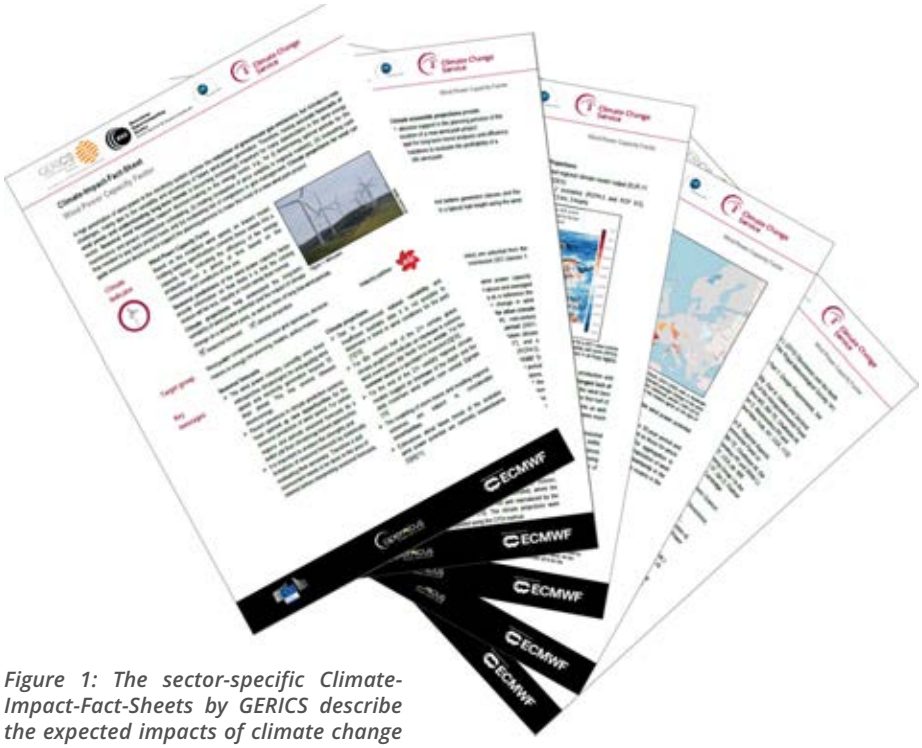

Figure 1: The sector-specific Climate-Impact-Fact-Sheets by GERICS describe the expected impacts of climate change on individual industries. The first set focuses on the energy sector

So, what if there was a place, where the most relevant information for the energy sector on regional climate change impacts was stored – easy to access and to understand?

Indeed, there is such a place: GERICS further developed its well-established methodology to create country Climate-Fact-Sheets and designed sector-specific Climate-Impact-Fact-Sheets. The first set of sector-specific Climate-Impact-Fact-Sheets look at the energy sector in Europe (see Figure 1). In this case, a set of six Fact Sheets were developed, focusing on very specific topics (see Figure 2).

Each Climate-Impact-Fact-Sheet shows a brief summary on the first page: it outlines the purpose of the Fact Sheet in context, along with the sector of interest and introduces the indicator used to estimate the relevant climate change impacts. This is combined with a quick overview of the most important key messages regarding climate

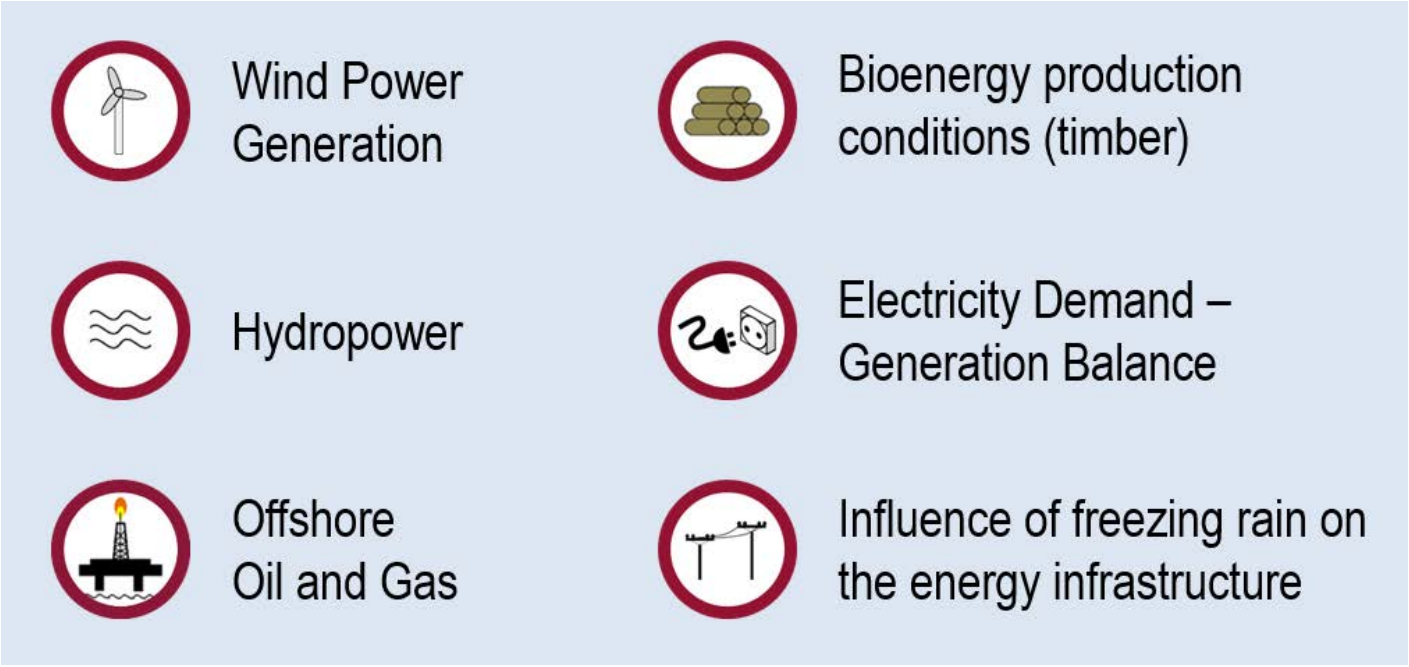

Figure 2: The sector-specific Climate-Impact-Fact-Sheets on climate change impacts are available for six topics related to the energy sector

change research for this indicator, and the practical implications for the respective industry. The following three to four pages provide more details on the methodology used to estimate the impact indicator, indeed, they show a case study highlighting some possible applications of the indicator and embed the content in the broader European context.

The Fact Sheets are complemented by a focus paper, providing a general overview regarding expected impacts of climate change on the six topics related to the energy sector shown in Figure 2. It further includes statements by representatives of the energy industry highlighting the importance of regional climate information and knowledge for their line of work.

The well-established Climate-Impact-Fact-Sheet methodology was applied in cooperation with a number of European research institutions and the energy industry, within the framework of the Copernicus Climate Change Service contract Clim4Energy. As part of the Sectorial-Information-System, Clim4Energy is a proof-of-concept project that delivered nine energy-relevant pan-European indicators of climate trends and variability. The indicators are consistent across the different energy subsectors, allow for uncertainty estimations and are well documented. Guidance material demonstrates possible applications.

A visualization tool developed as part of the contract allows users to look at simple statistics on climate variables and energy indicators. Advanced data sets can be synthesised and downloaded in an easy and accessible way.

Clim4Energy was coordinated by the French Alternative Energies and Atomic Energy Commission (CEA). CEA partnered with the National Center for Scientific Research (CNRS), the Barcelona Supercomputing Center (BSC), the Finnish Meteorological Institute (FMI), Météo France, the U.K. Met Office, the Swedish Meteorological and Hydrological Institute (SMHI) and the German Climate Service Center (GERICS). From the industry, Clim4Energy was joined by the following energy companies: EDPR, FINGRID Oyj, METSÄTEHO OY, Montel, RTE – FRANCE, SHELL, STATKRAFT, TOTAL and VATTENFALL.

Further information is available under http://clim4energy.climate.copernicus.eu/ .

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Europe's environment: The power of data and knowledge

Executive Director of the European Environment Agency (EEA), Hans Bruyninckx sheds light on the power of data and knowledge where Europe's environment is concerned

Europe collects increasingly more data, enhancing our understanding of the environment. Earth observation data obtained through the European Union's Copernicus programme presents new challenges and opportunities to improve our environmental knowledge. Combining up-to-date Copernicus data with our existing knowledge base, the European Environment Agency (EEA) aims to empower policy makers and citizens across Europe in taking measures to address local, national and global challenges.

Since the first pieces of environmental legislation were adopted in Europe in the 1970s, public authorities have been monitoring and recording different elements to understand environmental issues and trends. In some cases, even citizen groups, such as birdwatchers, have collected data to support nature conservation. EU legislation often sets specific parameters to measure progress towards the targets set in the legislation. Today, European countries monitor and report significant amounts of comparable data, ranging from greenhouse gases released into the atmosphere to municipalities' recycling rates.

The knowledge and understanding of environmental issues have gradually grown along with the number of data flows on specific issues. As our knowledge grew, so did our awareness and understanding of the strong links between thematic and sectoral observations. Consequently, European policies have evolved from issue-specific legislation to wider, systemic policy packages.

Mainly through its Eionet network, the European Environment Agency currently works with more than 100 different data flows involving up to several hundred institutional partners in 39 countries. These highly comparable and coherent data sets have helped us understand some key issues affecting the state of Europe's environment.

Understanding the knowns and the unknowns

Despite these significant gains in our knowledge, observations and data streams still remain to some extent fragmented across topics, time and space. Almost all the assessments we have published in recent years, including our latest state of the environment report (SOER 2015), stress the complex and global nature of key environmental problems, as well as the interlinkages between them. It is impossible to understand air pollution without considering what happens on land and in the oceans. Similar limitations exist when we focus on an area.

For example, thousands of monitoring stations across Europe collect air samples at a given frequency, analyse and report concentration levels of key air pollutants. This data flow is a major step towards a better understanding of the quality of the air we breathe. Nevertheless, it remains limited to time-specific readings that are only fully relevant within meters of that monitoring station.

The air quality in the areas between monitoring stations has been relatively unknown until recently. Satellite observations and increasingly more accurate computer modelling of big data are changing this – and not only for air quality monitoring.

Combining satellite and in-situ data: Copernicus

The European Union has been investing in earth observation through its Copernicus programme, which involves not only high-resolution satellite imagery, but also in-situ observations collected through sensors on

the ground and in the soil, weather balloons, buoys and deep ocean sensors, for example.

Copernicus satellites can monitor and transmit a large spectrum of earth observation data, ranging from the chemical composition of the atmosphere to changes in vegetation during the growth season. All Copernicus data and information products are accessible online and free of charge.

Copernicus is organised around six services: atmosphere, marine environment, land, climate change, emergency management and security. The European Commission is responsible for the overall coordination, while the implementation of individual core services involves all the main key earth-observation actors in Europe. Since 2012, the European Environment Agency has been coordinating the pan-European and local components of the land monitoring service, supporting applications in a variety of domains, such as spatial planning, forest management, water management, nature conservation and agriculture. The EEA is also coordinating the Copernicus in-situ component across all core services.

The potential of what we can collectively achieve with such data is immense. By combining an increasing number of data sets, we can understand better what is happening where, why it is happening and who will be affected by it and how. Imagine monitoring changes in water quantity in areas across Europe as detailed as 10 by 10 meters, or how the crop production will be affected in the short run and when factoring in the long-term impacts of climate change. Our Air Quality Index with up-to-the-minute data could be developed further to include accurate air quality projections with shifts in wind or other weather patterns factored in.

Big data: challenge and opportunity

Big data – consisting of large data flows of detailed, spatial and time-specific measurements as well as crowd-sourced data – can certainly present new challenges for data handlers in terms of IT infrastructure and processing power. Moreover, increased amounts of data will not automatically result in a better understanding of the environment or of the interlinkages between environmental problems. Handling big data requires as much investment in analytical capability as it does in IT infrastructure.

We, at the European Environment Agency, are both a contributor and a core user of Copernicus services, integrating its outputs into our assessments and knowledge base. And we have already started developing our assessment capability, including investing in cloud-based IT services and partnerships to accommodate the handling of big data. Our objective is to share this more detailed, accurate and timely knowledge with authorities and citizens across Europe and help to improve Europeans' health and Europe's environment. ■

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Supporting the protection of the green belt in the UK

Paul Miner, Head of Strategic Plans and Devolution at the Campaign to Protect Rural England explains why the organisation strongly supports the green belt policy in the UK

The Campaign to Protect Rural England (CPRE) exists to protect the English countryside as a whole. We are particular supporters of green belt policy.

The lessons of continental Europe and North America show that the particularly strong controls over development that green belt policy provides are needed around our largest towns and cities. Otherwise, there would be urban sprawl and loss of productive farmland. If London sprawled outwards like Los Angeles there would be an endless ribbon of development all the way to Cambridge and Brighton. Green belts remain strongly supported by the public, even if they don't always understand all the nuances of green belt planning policy. In 2015, 64% of the public supported green belt policy, a figure rising to 72% in the south of England.

In recent years we've seen that many in the rest of the country feel left behind. Levels of investment in transport and housing across the country are clearly inequitable. Green belts can help us to move towards a fairer development pattern across England, by restraining the impulse to make a quick killing by building on every last space around London.

Green belt policy has always been very effective in preventing urban sprawl. However, the designation is now under pressure from both development proposals and some commentators calling for policy deregulation.

In May 2017, we found that green belt boundaries are now changing at the fastest rate for at least two decades, enough to accommodate over 425,000 houses. This is also triple the amount proposed in the former regional plans, which the former Secretary of

State Eric Pickles abolished because they threatened the green belt. The vast majority of the land being allocated in plans is greenfield and the number of houses being permitted on undeveloped greenfield land in the green belt has nearly doubled since 2012, from just over 1,600 per year to more than 3,600.

> "The lessons of continental Europe and North America show that the particularly strong controls over development that green belt policy provides are needed around our largest towns and cities. Otherwise, there would be urban sprawl and loss of productive farmland. If London sprawled outwards like Los Angeles there would be an endless ribbon of development all the way to Cambridge and Brighton."

We believe that this increasing salami-slicing of the green belt needs to stop because:

- There is a lack of affordable housing for people on average or lower incomes and/or needing rented housing, being provided on most new schemes in the green belt. We calculate that no more than 28% of the 425,000 planned new houses are intended to be affordable. On sites where planning permission has been granted, only 16% of the houses permitted since 2009 will be affordable and this total includes new student housing.

- It is more difficult and costly to build housing at a large scale in the green belt than many of its detractors argue. The MP Siobhain McDonagh has recently stated that it is possible to build a million new houses on 20,000 hectares of green belt land near to train stations on the edge of London. The claim assumes that the new housing will be built at the relatively high average density of 50 houses per hectare. In many cases, this will simply not be possible on a green belt site, due to the need to also provide other supporting infrastructure such as roads, schools, sewerage and so on. Also, the mapping underlying the claim does not consider environmental assets such as public footpaths, ancient trees or hedgerows. Moreover, taking a general approach to building on green belt land close to train stations is likely to increase home value. This will make it more difficult to provide affordable housing on the land.

- There is considerable scope to make better use of brownfield sites in urban areas both within and beyond the green belt. Our campaigning led to local authorities now being required to produce brownfield registers and these have already identified enough sites to provide 1 million new homes across England. We should prioritise investment in cleaning up contaminated land and providing housing better linked to all the facilities of urban areas.

- We have the opportunity to manage green belt land better for farming, wildlife and people through retaining the commitment to long-term protection. We've found that environmental stewardship schemes cover 53% of all farmland in the green belt and that 48 new Local Nature Reserves (LNRs) have been created in the green belt between 2009 and 2015, representing 30% of all the new LNRs in England.

We're campaigning for the government to support farming in green belt areas through our work on the Agriculture Bill. Alongside this, CPRE is calling for green belt protection to be strengthened in the revised National Planning Policy Framework (NPPF), expected to be published later in 2018. We believe that if green belt boundaries do need to change, then the sites identified for release should be the least harmful in terms of sprawl or encroachment into the open countryside. Development that takes place should mostly be affordable housing for local needs. ■

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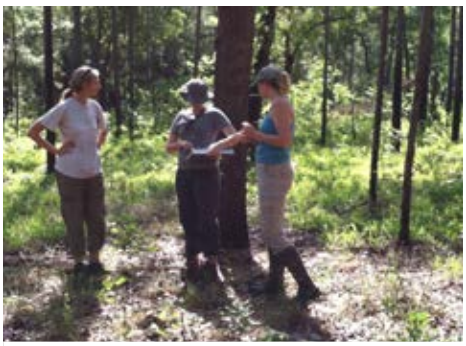
Recognising the important role of biodiversity

Pamela S. Soltis, Director, University of Florida Biodiversity Institute, reveals the key work being done in the U.S. to respond to the 'biodiversity crisis'

Biodiversity refers to the extraordinary variety of life on Earth. While widely accepted that natural biological diversity is fundamental to a healthy, sustainable planet and that its loss has negative impact on human well-being (for example, see Science magazine, July 2014), the connections between biodiversity, ecosystem function and services that contribute to human well-being – from the flow of fresh water to pollination of crops – are less well understood. Ecological economists note the effect of invasive species (>$120 billion annually in the U.S. alone) and have begun to quantify the economic benefit of ecosystem services, but less is known about the impact of lost ecosystem services on other aspects of both environmental and human well-being.

Global responses to societal problems arising from both loss and alterations of biodiversity suffer from insufficient information and inadequate policies for sustainable use of natural resources, in part, due to the slow rate at which biodiversity data are gathered and the difficulty in accessing the information once it is available. Consequently, much of the diversity of our planet is likely to disappear before it can be discovered and understood. This "biodiversity crisis" – that is, the loss of biodiversity and its attendant consequences – creates both the necessity and the opportunity for a new type of response.



Why biodiversity matters

Recognising the important role of biodiversity in the biological and sociological health of the planet, the U.N. declared 2010 the "Year of Biodiversity" and 2011-2020 the "Decade on Biodiversity" to focus attention on the accelerating loss of biodiversity in the face of human population growth, landscape modification and climate change. In 2011, the U.S. President's Council of Advisors on Science and Technology called for improved accounting of ecosystem services and greater protection of environmental capital, citing the need for further biodiversity science and application of informatics to enhance our understanding of ecosystem services and develop an appropriate policy to protect them.

More recently, the International Platform on Biodiversity and Ecosystem Services (IPBES), with 118 member nations and modelled after the Intergovernmental Panel on Climate Change (IPCC), has begun assessing the scientific and social knowledge of Earth's biological diversity and how environmental change will impact ecosystems and human societies. Like IPCC, the IPBES does not conduct primary research but assesses knowledge and attempts to influence policies aimed at protecting ecosystems and pursuing sustainable economic growth.

The recent establishment in the U.S. of NEON (the National Ecological Observatory Network) is beginning to provide extensive environmental data

and baseline ecological monitoring at select sites across the country, with fully operating data streams from nearly all sites now in place. Current and future assessment targets include the impact of declines in pollinator populations on food production, invasive species and habitat degradation, all topics that will threaten food security during the coming century and are relevant to agencies such as the U.S. Department of Agriculture, which governs not only food production, but also forestry in the U.S. Despite an increased awareness, more integrated, accessible science and technology platforms are needed to leverage novel planetary data, models and tools to create and link knowledge to policy.

The University of Florida (UF) Biodiversity Institute

The University of Florida (UF) Biodiversity Institute was launched in 2016 to bring together scientists, social scientists and policy experts to address critical societal issues of the 21st century related to biodiversity: invasive species, emerging pathogens, climate change and food security, to name a few. This interdisciplinary institute is accelerating synthetic research on biological diversity to serve stakeholders in Florida (a biodiversity hotspot) and globally through efforts to understand and manage biodiversity, develop relevant conservation, educational and outreach programmes and shape policy to protect and enhance environmental capital.

The Mission of the UF Biodiversity Institute is to conduct high-quality research and develop programmes to advance three primary goals: (1) Initiate and lead large-scale, collaborative biological surveys to document and monitor biodiversity on a global scale; (2) Conduct collaborative and interdisciplinary research on biodiversity, with an emphasis on the use of big data; and (3) Translate biodiversity science to solve major societal problems.

> "The UF Biodiversity Institute has already established strong links to data science, informatics, computer science and engineering, as well as to specialists in environmental law, agricultural economics, climate science, land use and human population growth."

The UF Biodiversity Institute is exploring the world's past and present biological diversity at scales from molecules to ecosystems and the relationship of biodiversity to climate change and to healthy and sustainable natural and human environments. Institute scientists conduct synthetic research using data from all relevant sources to address fundamental problems in biodiversity science and solve pressing societal problems. Newly synthesised knowledge from the institute is available to individuals and organisations seeking validated biodiversity information.

The UF Biodiversity Institute has already established strong links to data science, informatics, computer science and engineering, as well as to specialists in environmental law, agricultural economics, climate science, land use and human population growth. The institute benefits from strong ties to iDigBio, the U.S. national coordinating centre for digitisation of biodiversity collections – that is, the integrated database that shares biodiversity data for the nation's natural history specimens. iDigBio currently serves 110 million specimen records, representing approximately 300 million of the estimated 1-2 billion specimens in U.S. collections. This growing resource is driving innovations in management, analysis and interpretation of biodiversity data, both in the U.S. and globally, with a promise to address problems ranging from food security to invasive species to the response of species to climate change.

In a recent series of articles on the UF Biodiversity Institute, we have addressed the resources of iDigBio, the global need for innovative biodiversity training programmes for students and practitioners to take advantage of ongoing developments in data availability and use, as well as the economic value of ecosystem services.

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The future of green shipping in the Baltic Sea

HELCOM Secretariat's Markus Helavuori and Alexey Bakhtov provide an update on the future of green shipping in the Baltic Sea

The density of shipping in the Baltic Sea is steadily growing, with already more than 2000 ships navigating simultaneously at any given moment. While shipping is the most efficient and environmentally friendly mode of transport, its impacts on the environment are not negligible. There are various discharges to the water and air emissions consisting inter alia of sulphur oxides (SO_X), nitrogen oxides (NO_X), particles and CO_2, making up a significant part of total emissions in port cities.

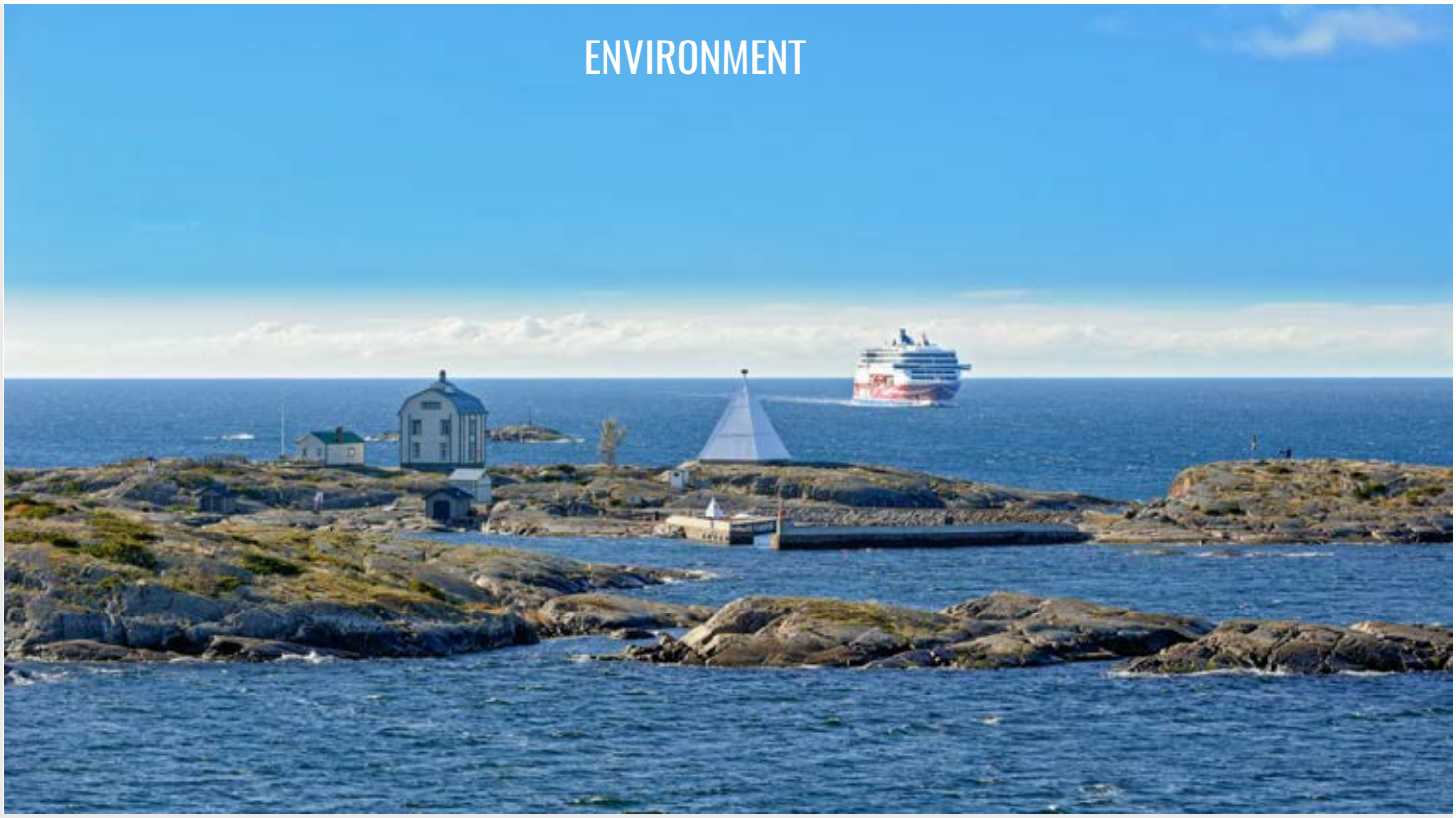
The core of the environmental regulatory framework for international shipping lies within the International Maritime Organization's (IMO) MARPOL Convention, but a number of other legislative measures are also in place to govern the development of "green shipping" in the region. These include EU legislation, the 1992 Convention on the Protection of the Marine Environment of the Baltic Sea Area (Helsinki Convention). Through the Baltic Marine Environment Protection Commission (Helsinki Commission, HELCOM), which is the governing body of the Helsinki Convention, the Baltic Sea countries have also developed and agreed on various HELCOM recommendations related to reducing emissions and other impacts from ships.

Continuous progress is being made in limiting the impact of shipping on human health and the environment. A significant milestone was reached on 1 January 2015 when amendments to Annex VI of MARPOL entered into force. The Baltic Sea was declared a Sulphur Emission Control Area (SECA), meaning that ships have to use fuel with less than 0.1% sulphur by weight. Stricter regulations for garbage and sewage discharges have been adopted in recent years and in 2017 the IMO's International Ballast Water Management Convention entered into force, aiming to prevent the introduction of invasive aquatic organisms. In April this year, the IMO came to a historic agreement on an initial strategy on the reduction of GHG emissions from ships. Furthermore, from 2021 all new ships will have to meet strict NO_X emission limits in the Baltic Sea and other NO_X Emission Control Areas.

As these developments are not effective overnight – many of the regulations have a phase-in period and a full renewal cycle of the Baltic Sea fleet may take 30 years – regional and voluntary measures are also called for. This may include economic incentives to speed up reductions in emissions via alternative fuels and improvement of energy efficiency. The development of innovative green technologies is also important for this development. Since 2017 the new HELCOM group on Green Technology and Alternative Fuels for Shipping (GREEN TEAM) has brought together government officials, industry representatives and other stakeholders in order to develop incentives for green investments, develop common standards and remove regulatory bottlenecks.

The maritime industry is moving rapidly into the future with digitalisation and automation already emerging. Environmental developments are largely related to non-traditional fuel types, cleaning of exhaust gases and improvements in energy efficiency. Most ships in the Baltic Sea use petroleum fuels (heavy fuel oils (HFO) and distillate oils (MGO, MDO). The use of liquefied natural gas (LNG) is, however, rapidly increasing. By using LNG, ships are able to reduce their emissions beyond the international requirements and there is also a CO_2 advantage.

In the Baltic Sea region, several projects on the installation of LNG facilities in ports were implemented between 2012 and 2015 through the TEN-T (Trans-European Transport Network) programme which co-funded more than 20 such initiatives. Its successor, CEF Transport (Connecting Europe Facility) through a horizontal priority "Motorways of the Sea" aims to develop a sustainable maritime transportation system through the implementation of green solutions at sea.



Nevertheless, only a few LNG terminals are in full operation to date, while a number are still in the planning or construction stages. EU member states are encouraged to develop their own national policy frameworks to stimulate the use of alternative fuels, particularly for ships. In reality, the breakthrough solutions are only sporadic and mainly confined to certain forerunners in the Baltic Sea.

A rapidly increasing number of LNG ships are either in service or on order in the Baltic Sea. The first LNG fuelled passenger ferry in Finland, *Viking Grace*, was recently modernised to become one of the first ships in the world with a Flettner rotor sail unit. Two Swedish shipowners have contracted two additional product/chemical tankers with LNG propulsion, to be delivered during 2018 and 2019 respectively. Featuring a dual fuel/LNG propulsion using biogas, the vessels will have achieved a significant reduction of CO_2 emissions.

Methanol-powered propulsion is another example of green shipping already in operation, for example, methanol fuelled *Stena Germanica* began operating in 2015 and plans are being made both for new methanol powered ships, as well as converting existing ships to use this type of fuel. In the foreseeable future, it is expected that battery power will be used at Stena Jutlandica for bow thrusters and maneuvering at port, as well as on the main propulsion system during the route between Gothenberg and Frederikshavn.

Small-scale initiatives deserve a special note. Among them, the electrically-powered ferry *MS Sjövägen* is running between 10 stops on the waterways of Stockholm. The first Danish ferry powered by LNG – *The Samsø Ferry* is expected to eventually be fuelled by local biogas. In Finland, there is another innovative example: a company with ships using biofuels and even its own production plant making biofuels out of industrial side streams and recycled materials.

Many more innovative shipowners and technologies are emerging in the Baltic Sea region, but they are still outnumbered by more traditional ones. Also, a lack of infrastructure is still a reality requiring significant investments. Uncertain financial prospects are another bottleneck, making large-scale green shipping in the Baltic Sea region still something to strive for into the future. ■

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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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Earth science education in the UK: From volcanoes to landslides

Dan Boatright, Chair of the Earth Sciences Teachers Association (ESTA) focuses on earth science education in the UK – from volcanoes to landslides and why geologists today are in demand

As a geology teacher in England, I am repeatedly asked the same question: 'Isn't geology just the study of rocks?' My response is now to ask them for their mobile phone. Within two minutes, they understand why they should think about being a geologist. From the lithium in the battery to the various conductors and electronic components, that mobile phone needs geologists. Some are needed in front of computer screens, using the latest technologies to find potential reserves of minerals, others in the field to find the most accessible mining locations and even more in schools and colleges, enthusing the next generation of earth scientists so that we can continue to be world leaders in this important science.

In England and Wales, we are very fortunate, with students able to study earth sciences as a discrete course at GCSE and A Level (14-19 years old). While it is not available in all educational institutions, there is a strong demand where it is taught. Students are often attracted to the course because of what they have seen in films (The Jurassic Park and World franchise provides a big boost to numbers when released!) and recent events in Hawaii have resulted in large numbers of students wanting to become volcanologists. What is most interesting about this attraction is that it is rarely where the student's interests remain. Volcanic eruptions, such as the 2010 Eyjafjallajökull, always inspire students to consider the practical implications of living near such a dangerous force of nature, but students often find that the practical considerations closer to home, such as sink-holes, landslides and mineral extraction, are less glamourous but far more lucrative as career opportunities.

Geology GCSE and A Level teaches students all the fundamentals of the subject: how to identify and interpret geological materials – from minerals and rocks to fossils and geological structures – and then how you can use this information to recreate past environments. Students then use this information to discuss the practical and environmental issues of extracting minerals, the geotechnical issues of constructing dams and tunnels, as well as the issues of living in tectonically active environments. These qualifications put students in an ideal position to further their education at university or progress into work-based programmes with engineering companies.

In the UK today, geology offers an interesting and exciting career; in an academic setting, working at the forefront of modern research, working for engineering companies building bridges and sea defences, or ensuring that current and new housing is not at risk of collapsing into a sink-hole or a historical mine shaft. Geology education at school and college provides an important portal into university education and has become integral to ensuring more people enter this profession. There are, however, opportunities to expand geological education in the UK, with Scotland lacking any earth science education before university and there are plenty of locations within England and Wales, particularly within inner cities, where geology is not yet taught. This has become the priority of the Earth Science Teachers Association (ESTA), universities and the Geological Association of London, to ensure that earth science education is available to all students across the UK today. ■

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Promoting polar science in the United States

The work of the Office of Polar Programs (OPP), part of the National Science Foundation (NSF), is examined here by Open Access Government

Within the National Science Foundation (NSF), the Office of Polar Programs (OPP) exists to promote innovative and creative scientific research that concerns the polar regions. They achieve this by catalysing fundamental understanding and discovery of polar systems and their global interactions to educate the United States and to advance the welfare of everybody.

Science, Technology, Engineering and Mathematics (STEM) engagement and workforce development (education & people) are very much a part of OPP's remit, as they aim to undertake their duties in a collaborative and sustainable manner. OPP works with a wide array of partners, including native Arctic communities and Alaskan residents from the polar regions, as well as local, state, federal and international educational and research agencies and institutions.

Ice stream draining Greenland Ice Sheet

One of the many examples of research highlighted on OPP's website is all about a study which shows that a ribbon of ice more than 600 km long that drains around 12% of the gigantic Greenland Ice Sheet which has been smaller than it is today, a new study explains. We find out that the loss of ice from the Northeast Greenland Ice Stream (NEGIS) took place during the warm Holocene period, and during a time preceding the last glacial maximum that is thought to be very cold one, the researchers argue.

"There are some parts of the ice sheet that are relatively stable and others that show evidence of very rapid retreating – a pattern we're seeing today as well as thousands of years ago," says Anders Carlson, from Oregon State University, who is a co-author of the study. "Some of it relates to bed topography – when the bed is below sea level, it stabilises that part of the ice sheet. In low spots, it is unstable", he adds.[1]

International Thwaites Glacier collaboration

In other recent news, we learn that the collapse of the Thwaites Glacier in West Antarctica could affect global sea levels significantly. In April, the National Science Foundation (NSF) and the United Kingdom's Natural Environment Research Council (NERC) announces that teams of scientists in various U.S. institutions will deploy to Antarctica to collect the data required to find out if the glacier could begin to collapse during the next few decades or centuries.

This is part of a new $25 million research collaboration, which will continue until 2021 and we discover that The Thwaites Glacier already drains an area that is similar to the size of Britain or the state of Florida, which accounts for around 4% of global sea level rise.

"Satellites show the Thwaites region is changing rapidly," says William Easterling, NSF assistant director for Geosciences. "To answer the key questions of how much and how quickly sea level will change requires scientists on the ground with sophisticated equipment collecting the data we need to measure rates of ice-volume or ice-mass change. The challenges of conducting fieldwork of this scope and scale in such remote locations are enormous. The only practical way for nations to do this is to work collaboratively, each bringing scientific and logistical resources to enable complex and comprehensive field studies", he adds.

The Office of Polar Programs manages the U.S. Antarctic Program, which will support the collaboration's researchers and provide U.S. logistics for the project's vital work. "The fate of the Thwaites Glacier is one the big unknowns in Antarctic science," says Duncan Wingham, NERC's chief executive. "We currently do not know enough about the likelihood, timing and magnitude of the collapse of West Antarctic glaciers such as Thwaites to be able to plan accordingly. NERC and NSF, working

together, are uniquely placed to attempt to reduce the scientific uncertainty about these unknowns, providing answers to one of the most important questions facing us about global sea level rise", he adds.

"Within the National Science Foundation (NSF), the Office of Polar Programs (OPP) exists to promote innovative and creative scientific research that concerns the polar regions. They achieve this by catalysing fundamental understanding and discovery of polar systems and their global interactions to educate the United States and to advance the welfare of everybody."

This is the largest joint project undertaken by the two nations in Antarctica in more than 70 years and includes about 100 scientists from research institutes in both countries alongside those other nations, including Germany, Sweden, South Korea, New Zealand and Finland. Kelly Falkner, director of NSF's Office of Polar Programs, underlines that the U.S. Antarctic program has: "decades of experience in supporting large-scale international research initiatives – from building the world's largest neutrino detector at the South Pole to supporting ice-core and sediment drilling projects that provide glimpses into the thawing and freezing of Antarctica over timescales of millions of years."[2]

In closing, it's worth just saying that these two examples illustrate the Office of Polar Programs clear aim to promote, "creative and innovative scientific research...in and about the polar regions, catalysing fundamental discovery and understanding of polar systems and their global interactions to...advance the welfare of all people."[3] ■

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The Antarctic notothenioid fishes: An especially interesting and unique marine species flock

Arthur L. DeVries, from the University of Illinois provides a comprehensive insight into a unique marine species flock, the Antarctic notothenioid fishes

At one time the Antarctic Ocean was home to a temperate fish fauna which included sharks, rays and bony fishes (teleosts). About 20 million years ago the Antarctic waters began to cool and all the temperate fishes died out, except for a bottom-dwelling fish that probably looked like a northern hemisphere sculpin. This hypothetical ancestor gave rise to a group of closely related fishes that survived the cooling waters, which today are known as the notothenioid fishes: (a sub order Notothenioidei nested within the modern bony fishes (Perciforms). Some of the shared features of this group are the lack of a swim bladder making them negatively buoyant in seawater, paired pelvic and pectoral fins positioned one above the other and just distal of the opercula and mostly benthic species.

This suborder includes eight families most of which are found in the Southern Ocean south of the Antarctic convergence. Members of five of the eight families are primarily confined to the narrow shelf region of the Antarctic continent. The families include the Nototheniidae, Channichthyidae, Bathydraconidae, Artedidraconidae and Harpagiferidae. They make up about 90% of the fish biomass of the shelf and the populations of some of the species are huge. The other three families (fig 1) are confined to the waters of the sub-Antarctic islands and the Patagonian region of South America.

When the waters surrounding the Antarctic continent began freezing – a novel trait evolved in some of the progeny of the notothenioid ancestor – which permitted them to avoid freezing; this trait was a blood-born glycoprotein which had antifreeze properties. This antifreeze glycoprotein (AFGPs) lowered its blood freezing point a few tenths of a degree below the freezing point of seawater (-1.9°C). The antifreeze trait allowed them to survive and diversify into many species which filled the ecological niches vacated by the extinction of the temperate fish fauna. Presently, there are a variety of body morphs. Some of the nototheniids and harpagiferids resemble north temperate bottom dwelling thorny sculpins (Cottids).

Other species of the nototheniid family are like smelt and salmonids in body form with a fusiform shape. The nototheniid, Trematomus borchgrevinki inhabits the waters at the underside of the fast ice and finds refuge in the platelet layer and has a body form similar to a codfish. The two nototheniid fishes, Pleuragramma antarctica (Antarctic smelt) and giant Antarctic toothfish, Dissostichus mawsoni inhabit the water column and are neutrally buoyant even though they lack a swim bladder. They have achieved neutral buoyancy by reducing mineralisation of their skeletons and scales and accumulating lipids which are less dense than seawater. The smelt accumulates sacs of clear lipid under its skin and between its dorsal vertebral spines. Neutral buoyancy adaptations allow these two species to cruise through the water column expending energy only for directional swimming rather than swimming to counteract sinking.

Channichthyids, often called crocodile fishes because of their large mouths as adults are sit and wait predators and can gulp and swallow a fish half their size. The most amazing trait found in this family is the lack of red blood cells and hence hemoglobin the oxygen transport pigment. Oxygen taken up at the gills is transported only as dissolved oxygen in their hemoglobinless blood.

However, they have evolved adaptations to partly overcome the lack of hemoglobin such as larger gills for a larger gas exchange surface to absorb oxygen, a larger blood volume with a larger heart and the absence of scales which allows some gas exchange through the thin skin. Despite these adaptations, they do not tolerate stress like their red-blooded relatives

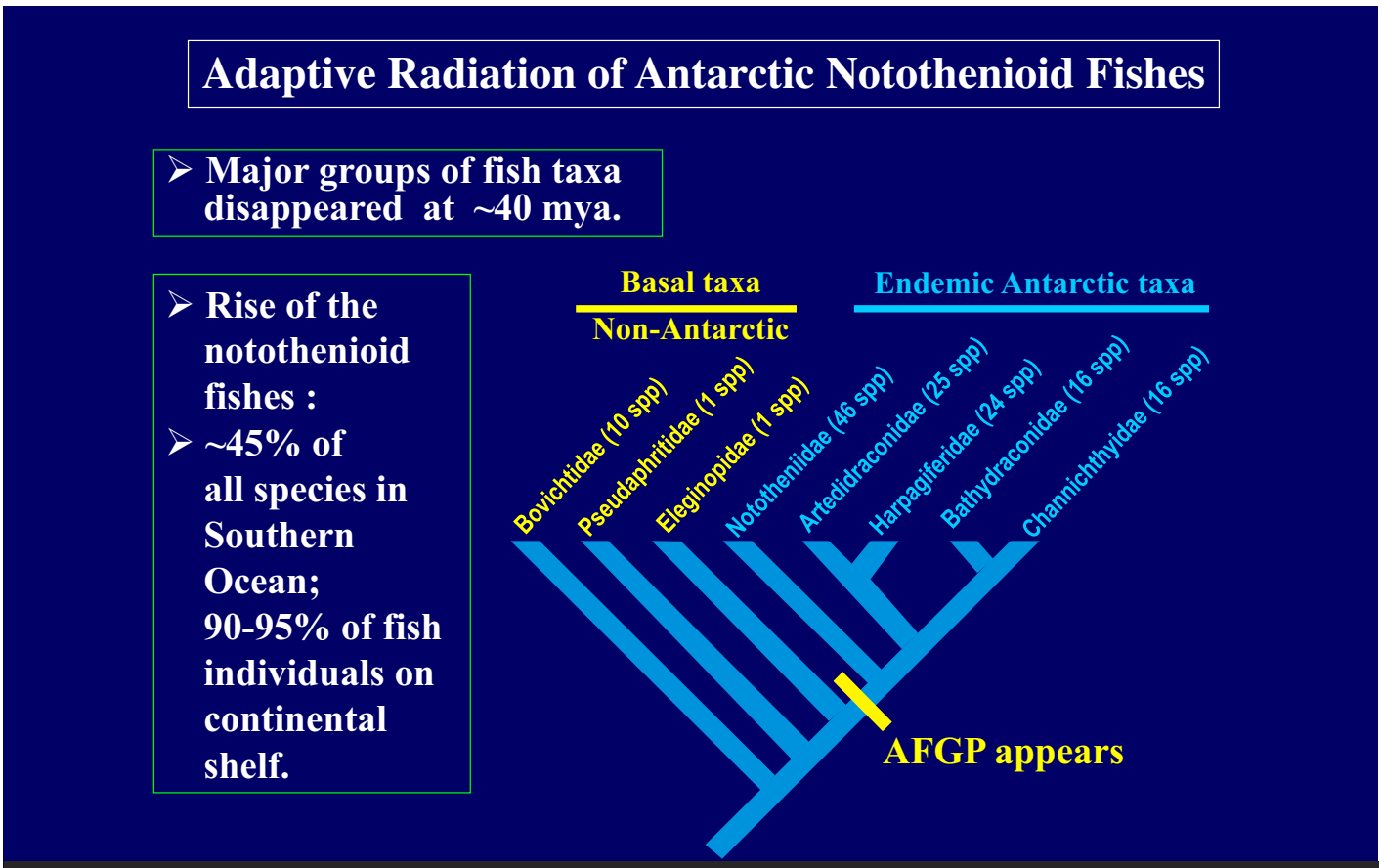

Figure 1. Cladogram of Antarctic fishes of the Suborder Notothenioidei and characteristics of the group

and are therefore at a physiological disadvantage relative to the other notothenioids.

However, they have been able to survive for millions of years because the cold Antarctic Ocean contains more oxygen than warm temperate waters because oxygen solubility is greater in cold water than warm water. The presence of one species of the channichthyid species in 12°C waters of Tierra del Fuego exemplifies the creativity of evolution as this one species can tolerate temperatures well above those ice fish species endemic to the Antarctic Ocean which fail to survive at temperatures higher than +6°C. Although this South American fish appears to exist near it physiological limit, it does attest to its evolutionary success despite having to compete with many coexisting red blooded species, such as salmonids and other non-Antarctic fish species.

The notothenioid group is an excellent example of a marine species flock. That is, a closely related clade of species that arose from a common ancestor and underwent an adaptive radiation that gave rise to a variety of species with unique morphological and physiological characteristics that allowed them to successfully invade and fill most of the underutilised ecological niches that were vacated by the extinct temperate fauna. Because they are closely related the similarities and differences in some of their biochemical, physiological and morphological traits can be more easily compared without having to deal with a phylogenetic signal that would be present if they originated from unrelated ancestors.

Thus, a clearer picture can be gleaned from comparative studies of their morphological, biochemical, physiological adaptations and the underlying genomic changes that gave rise to them. This marine species flock is like the African Rift cichlids which also arose from a common ancestor and evolved into hundreds of species which exhibit morphological, behavioural and reproductive differences and utilise different ecological niches in the fresh water lakes.

ILLINOIS

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Understanding earth and environmental processes

Open Access Government explores the work of the public-sector body, the British Geological Survey (BGS), in helping us to understand earth and environmental processes

As a world-leading geological survey, the work of the British Geological Survey (BGS) focuses on public-good science for the government, as well as research to help us understand earth and environmental processes. The BGS has surveyed the UK's geology since 1835.

Today, BGS provides authoritative and objective geoscientific data, information and knowledge to help society use its natural resources responsibly, be resilient to environmental hazards and manage environmental change.

As a public-sector body, BGS advises the UK government on every aspect of geoscience, as well as supplying geological advice to academia, industry and the public. It is also worth pointing out that BGS is part of the UK's primary agency for funding and managing research, training and knowledge exchange in the environmental sciences – the Natural Environment Research Council (NERC). NERC reports to the Department for Business, Innovation and Skills (BIS), within the UK government.

In the UK, the BGS has their headquarters close to Nottingham, plus there are a number of regional offices in London, Cardiff, Edinburgh and Wallingford. Further afield, BGS is also a key player in an extensive programme of overseas research, that includes surveying and monitoring in the developing world.

In terms of the organisation's funding, half of it comes the Natural Environment Research Council (NERC) and the remainder from research grants, commercial data sales, commercial consultancy and other services.

Also worth highlighting here is that the data that BGS collects is deposited into their National Geoscience Data Centre – plus the samples and reports go to the National Geological Repository. The information deposited in these two places is used to build up the national geological database to assist the UK to make decisions about its natural resources.

The industries that have been and remain principle providers of this geological information are construction, petroleum, mining and environmental. It is quite normal for these industries to collect significant geological datasets, but where data is collected via commercially sensitive projects, it can remain confidential. Having said that, where it is possible, BGS make their data and research available to the public, industry, regulators, government and academia by means of openly published reports, open data and as peer-reviewed science.

Volcanoes

One aspect of the BGS's work in the field of discovering geology concerns volcanoes. Looking at the UK, for example, we know that they have not been affected by volcanic eruptions. Having said that, we remember the 2010 and 2011 eruptions of the Eyjafjallajökull and Grismvötn volcanoes in Iceland, which created a major disruption to air traffic in the North Atlantic, as well as Europe.

In the view of BGS, such eruptions are not unusual, indeed for hundreds of thousands of years, ash from Icelandic volcanoes is said to be carried over to the British Isles. BGS is also concerned with the 14 UK Overseas Territories that are considered to be volcanically active, which are:

- Montserrat;
- Tristan da Cunha;
- Ascension Island and;
- The South Sandwich Islands.

On some of these islands, local communities live on the flanks of active volcanoes. Two of these islands have witnessed volcanic activity during the last few decades and as such, the BGS has played an important part in responding to these crises. For example, the Soufrière Hills Volcano in Montserrat, in the Lesser Antilles, began erupting back in 1995 and caused many of the inhabitants to leave the island. Today, an exclusion zone is still in place in the south of the island. From 1996 and 2008, BGS staff worked at the Montserrat Volcano Observatory (MVO) and still work closely with them today.

We also know that the natives of Edinburgh on Tristan da Cunha were temporarily evacuated in 1963 due to a volcanic eruption. BGS also responded to an offshore eruption near Tristan da Cunha, back in 2004. Also considered to be volcanically active, is Ascension, a populated remote island located in the South Atlantic Ocean.

Added to the above, we know that British citizens today travel overseas more than they did previously, indeed UK businesses are becoming ever more international where supply chains, communications and customers are concerned. In light of this, the BGS cooperates with governments, universities and volcano observatories to increase an understanding of the hazards and risks posed by volcanoes worldwide.

The BGS website draws our attention to one fascinating area where volcanoes are concerned, which is Iceland, described as a unique volcanic island. The BGS's website tells us more about this fascinating aspect of the organisation's important work in this area.

"It lies on the Mid-Atlantic Ridge, the great chain of underwater volcanoes that runs through the North Atlantic Ocean, along which the Eurasian and North American plates are moving apart at about 2.5 cm per year – or roughly the rate your fingernails grow."

Finally, Dr Brian Baptie, BGS Head of Earthquake Seismology sums up the work of BGS with the Iceland Met Office when it comes to monitoring of any future eruptions.

"BGS has worked in collaboration with the Iceland Met Office to install new seismic stations in the vicinity Eyjafjallajökull and Katla. These stations are providing real-time data to enable detailed monitoring of any future eruptions." ■

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Magmatic petrology and volcanology research

Olivier Bachmann, Professor of Volcanology and Magmatic Petrology at ETH Zürich tells us about the group's fascinating research into magmatic petrology and volcanology

The way our planet differentiated from an initially homogeneous state into a density-stratified structure with an atmosphere and hydrosphere is one of the most fundamental questions in the earth sciences. It also has practical consequences as igneous differentiation leads to volcanic activity and ore deposits on or near the surface of our planet. The group of Professor Olivier Bachmann (Chair of magmatic petrology and volcanology at the ETH Zurich) focuses largely on those topics. The main research areas of the group are (1) causes and consequences of large, explosive, volcanic eruptions, as well as their precursory signs, (2) magmatic differentiation and construction of the continental crust, (3) magma reservoir dynamics, (4) controls on eruptive styles (effusive-explosive transition) and (5) links between magmatic activity and ore deposits.

The group uses a variety of techniques, which involves field observations, geochemical analyses of natural and experimental samples, geophysical analyses, experimental work and numerical modelling to provide an integrated picture of the processes involved from magma generation deep inside the earth to magma differentiation and degassing in the shallow crust and eruption at the Earth's surface. Some of the main field areas in which these techniques have been applied included (1) Western North America, (2) the Andes, (3) the Aegean volcanic arc (Greece) and (4) the Naples area (Italy).

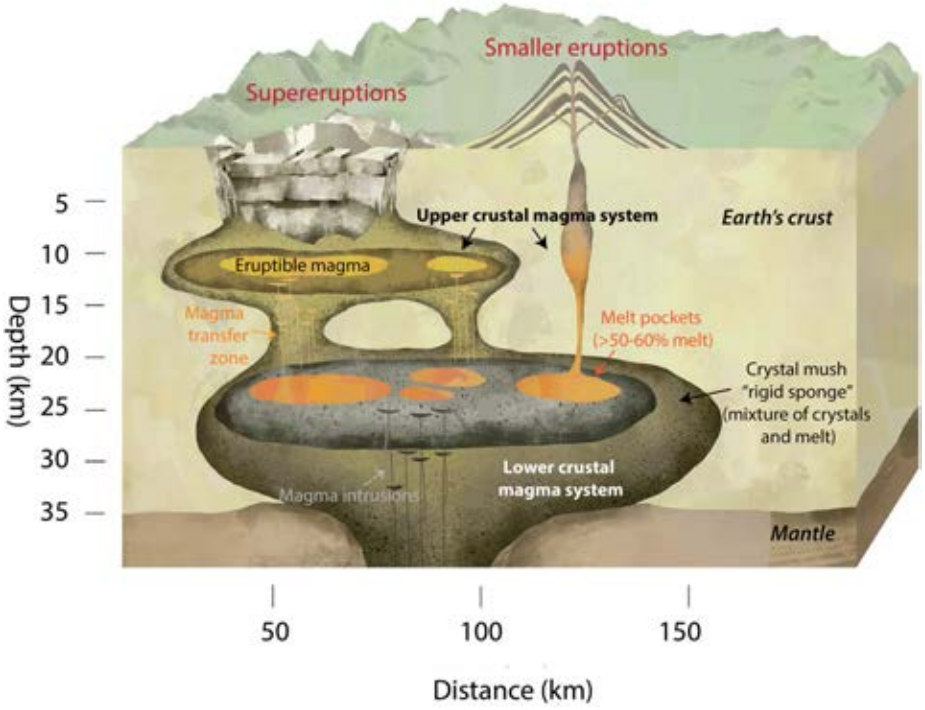

Figure 1: Schematic illustration of a magmatic mush column beneath a typical arc volcano (right) and beneath a supervolcano (left)

Over the last years, the magmatic petrology and volcanology group has developed several new ideas and concepts about how the magmatic engine of our planet works. Through careful analyses and well-designed experiments (both in the lab and on computers), the group has played a key role in constraining the role of magmatic mush columns (Fig. 1) in producing the continental crust on which we live and how such columns control the compositions of magmas that erupt at the surface.

The group has also participated in determining how and how fast, large magma reservoirs grow, leading to the so-called "super volcanic" eruptions. These events, albeit rare (every 50-100 kyrs based on actual data), are considered as the ultimate terrestrial hazard, releasing more energy than any other natural (and not so natural) phenomena, including atomic bombs, large earthquakes or hurricanes and are only matched by large meteorite impacts, although the latter is much less frequent (see recent lay people summary: "the making of a super volcano" for Pan European Networks, Science and Technology).

In the future, the group wants to continue focusing on the interaction between processes occurring deep within the earth and what happens at or near the surface. Better constraining

Field picture showing both the large deposits of a young explosive eruption in the Altiplano region of Argentina (outcrops in the foreground) and the rest of a sulfur mine in the distance ("Mina Julia"; the yellow hill in the background, peaking above 5000 m altitude)

Olivier Bachmann

(1) the hazards related to explosive volcanic events, (2) the impact of super volcanoes on our planet and (3) the precursory signs that large volcanic reservoirs send before they become unstable seem more important than ever in our heavily populated planet.

In addition, a better understanding the link between magmas and ore deposits seems key in today's world, where the pressure for getting resources continues to increase. To achieve these goals, striking the right balance between (1) gathering detailed information from the rock record in the field, (2) obtaining high-quality analytical data on carefully selected samples, (3) conducting targeted experiments to constrain thermo-chemical and physical properties of relevant earth materials and (4) designing advanced numerical models will be crucial. Within this framework, technical developments in geochemistry, geochronology and experimental petrology are particularly important for the group, as pushing the boundaries of state-of-the-art techniques are leading to important new discoveries. For example, the SEM-EMP, LA-ICP-MS and TIMS laboratories at ETHZ intimately shared among the groups in the Earth Science department have led to important studies over the last few years.

Teaching and outreach

The group has been involved in a large panel of teaching activities, ranging from the most basic courses about earth sciences for undergraduate students to advanced graduate classes and demanding field excursions/mapping classes. Recently, the group has taken in significant role in designing the new bachelor curriculum and building a new class, in which we try to lead students towards a more comprehensive understanding of important geological issues using a mix of teaching methods involving traditional lecturing, but also exercises, personal presentation and essay writing with lots of contact time between students and teaching staff.

Outreach is also fundamental, as it allows the public to better understand what scientists really do, leading to increased awareness about how science can help our society. Over the last few years, the group of prof. Bachmann has participated in several outreach activities to explain to the public the fundamental societal role of the earth sciences. Those activities range from scientific exhibits in Zurich to multiple talks at conference series around the world. Moreover, the group has been active in responding to the media (newspapers and television) whenever interviews were requested.

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Five tips for plastic use and sustainability in the laboratory

Inez Cornell, Marketing Manager at Radleys tells us her top tips for plastic use and sustainability in the laboratory

When the first fully synthetic plastic was invented in 1907 no one anticipated it would become a major environmental problem.

Plastic pollution is now such a widespread issue that this year's Earth Day in April was dedicated to ending it. In this article, Radleys covers five tips for reducing the reliance on plastic.

Why plastic is the problem

Unfortunately, one of plastic's most lauded properties – it's durability, is also one of the reasons it is such a problem. Plastic is so durable it can take hundreds of years to biodegrade. A plastic bottle, for example, takes roughly 450 years.

Then there's the issue with disposing of all the plastic we use. Lots of it ends up in landfill sites, or in our oceans, where it is ingested by marine life and ends up in the food chain. We don't yet know how this affects human health. The materials used to produce some types of plastic can also be an environmental problem because plastic is often made from hydrocarbon molecules that are derived from petrochemicals.

These figures show the staggering amount of waste plastic produces:

The total volume of plastic produced to date is estimated to be 8.3 billion tonnes. By 2015, plastic had already generated 6.3 billion tonnes of waste and 79% of this is now in landfill sites or the natural environment.

About 10 million tonnes of plastic is estimated to end up in the oceans each year.

A survey by Plymouth University estimated plastic is found in a third of fish caught in the UK, including widely eaten species such as cod, haddock and mackerel.

A study by the Ellen MacArthur Foundation found that if current trends continue, plastic will outweigh the amount of fish in the ocean by 2050.

It takes two-litres of water to produce the plastic for a one-litre bottle.

Scientific use

Scientific research contributes a significant amount of this plastic waste. Globally, it is estimated to produce five and a half million tonnes of plastic. Bio-scientific research alone is thought to be responsible for 1.8% of total global plastic production.

Plastic has a few properties that make it useful in the lab like being shatterproof, durable and lightweight. Widely used lab equipment such as multi-well plates, pipettes, bottles, flasks, vials and culture plates are all commonly made of plastic. To reduce the impact this is having on the environment, it is worth taking the following steps.

Look at your buying behaviours

Using plastic sustainably starts when you make the decision about what to buy and who to buy it from. It is, therefore, worth spending some time doing research into how your suppliers produce their plastic. Do they try to minimise the carbon footprint of their manufacturing process by taking steps like reducing their energy consumption and not using harmful chemicals?

You can also ask your supplier to cut down on unnecessary plastic packaging when they deliver your products. Some suppliers also have recycling programmes you can use when disposing of your plastic.

Also, consider what the plastic is made from. Polypropylene (PP) or high-density polyethylene (HDPE) materials are widely used for lab equipment and are recyclable. Be sure to opt for lab grade plastic which doesn't contain additives like plasticizers which can leach out.

How to reduce

Just because you've always used plastic for certain tasks, it doesn't mean there aren't other options out there. For example, in some cases, you might be able to use glass graduated cylinders instead of conical tubes. You can also get glass pipette tips and glass Petri dishes. Bulk buying is also a good way of minimising the carbon footprint when ordering your plastic consumables.

Can it be reused?

There is a tendency to treat plastic in the lab as a consumable when it may be possible to use some items more than once. Styrofoam cooling boxes, for example, can be repurposed and used in other ways for storage.

Pipette tip boxes can also be repurposed to hold other lab supplies, or as containers for Western blots. Or, you could opt for refillable tip boxes. Conical tubes and even pipette tips can be washed and autoclaved then reused.

Time to recycle

Look at all the plastic in your lab. Do you know what can or can't be recycled? A useful rule of thumb is that if the plastic is not characterised as a biohazard or radioactive hazard it may be possible to recycle it. Just make sure anything you recycle is decontaminated first.

Whenever you can, opt for thinner, lighter-weight plastic that is easier to compress and recycle. It is also best to avoid pipette trays and racks made of mixed plastic because these are difficult to recycle. And if you have gone to the effort of putting a recycling system in place, make sure it is easy to access and clearly explain what can and can't be recycled.

How we can play our part

Individually, the measures you take to reduce plastic pollution may seem like a drop in the ocean but together they soon add up. So why not get behind this year's Earth Day campaign and plan how you can reduce plastic pollution in your lab? ■

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Ocean sciences: Advancing the frontiers of knowledge

The activities of the Division of Ocean Sciences (OCE), a section of the National Science Foundation (NSF), in advancing the frontiers of knowledge around ocean sciences, are reviewed here by Open Access Government

The Division of Ocean Sciences (OCE) is a section of the National Science Foundation (NSF) in the U.S. that strongly supports research, infrastructure and education to further understanding of the global oceans and ocean basins, including their interactions with the integrated Earth system and human beings.

OCE's activities provide essential knowledge for addressing many of the U.S.'s most pressing challenges in the area of earth processes. OCE advocates collaboration in the field and encourages the development of a diverse scientific and educational community, at home and abroad.

Working in partnership with the U.S. ocean sciences academic community, OCE directs funding towards advancing the frontiers of knowledge, enhancing the public's understanding of ocean sciences and developing the next generation of researchers.

While OCE represents this community in the Federal context, they coordinate with international partners in areas such as funding for research and managing infrastructure. OCE also takes part in the development of policy by means of a number of forums and programmes in the U.S. and further afield.

NSF experiments on giant kelp

In recent news from OCE, we discover that a giant kelp can grow two feet a day and reach nearly 150 feet in length – in one growing season. Researchers affiliated with the NSF) Santa Barbara Coastal (SBC) Long-Term Ecological Research (LTER) site aimed to find out how giant kelp can maintain their impressive growth in seasons when nitrate all but vanishes.

Details of their findings on one of the fastest-growing organisms on Earth appeared in June 2018 in the journal, Limnology and Oceanography Letters. "This report provides an explanation for how giant kelp in Southern California is able to persist and grow when nitrate concentrations in coastal waters are extremely low," says David Garrison, a program director in NSF's LTER program, which funded the study.

"It turned out that kelp consistently showed no preference, and used urea at equal rates as ammonium," lead author Jason Smith of the University of California, Santa Barbara (UCSB) explains. "Our results suggest that there's enough urea available to sustain kelp growth when levels of ammonium and nitrate are low."

Having said that, calculating a rate of use for the

various compounds provided just some of the answer, we are told.

"We performed a set of controlled experiments on kelp tissue to prove that the urea molecule itself enters the tissue," Smith adds. "We're the first to document for any seaweed that the whole urea molecule is consumed, which greatly expands the known physiology of giant kelp and the kinds of nitrogen forms the plant can use."[1]

The impact of hurricanes on coastal ecosystems

In other news, we learn that scientists have set out to chronicle how two decades of hurricanes have affected North Carolina's Neuse River, the second-largest estuary in the U.S. The NSF supports this fascinating area of research through its Biological Oceanography and Chemical Oceanography programs, which included a rapid response grant following 2016's Hurricane Matthew.

> "OCE's activities provide essential knowledge for addressing many of the U.S.'s most pressing challenges in the area of earth processes. OCE advocates collaboration in the field and encourages the development of a diverse scientific and educational community, at home and abroad."

"One manifestation of climate change may be a higher frequency of storms," says David Garrison, a program director in NSF's Division of Ocean Sciences. "This study provides valuable insights into how coastal estuaries will be affected."

Hans Paerl, a scientist at the University of North Carolina at Chapel Hill adds: "Understanding how an increase in extreme events such as hurricanes affects coastal ecosystems is critical to preparing for a stormier future."

Understanding how coastal ecosystems respond to hurricanes and other major storms, including nor'easters and severe thunderstorms, says Paerl, "is important at a time when such extreme weather events are becoming more frequent and intense."

This perspective examines the effects of hurricanes on estuaries, also indicates that the increased CO in coastal waters could impact upon the climate. "The impacts of these infrequent but significant pulses of nutrients into sensitive coastal ecosystems have been mostly unknown," Paerl underlines.[2]

Dispersants to clean up oil spills

Finally, other news worth exploring concerns the NSF's research with the Woods Hole Oceanographic Institution (WHOI), which discovered that sunlight chemically alters crude oil floating on the surface of the sea within a matter of days or hours.

"It's been thought that sunlight has a negligible impact on the effectiveness of dispersants," explains Collin Ward, a scientist at WHOI and lead author of the study. "Our findings show that sunlight is a primary factor that controls how well dispersants perform. And because photochemical changes happen fast, they limit the window of opportunity to apply dispersants effectively."

Henrietta Edmonds, a program director in NSF's Division of Ocean Sciences, which funded the research adds, "This study shows how important it is to do basic research on the chemical reactions that take place in the environment. The results will help us learn how to effectively respond to oil spills."[3]

Final remarks

The above examples of research into the ocean sciences reveal exactly how OCE directs funding into areas that advance "the frontiers of knowledge", develop "the next generation of researchers" and enhance "the public's understanding of ocean sciences."[4] It also fits in with the wider aim of the NSF to "support basic research and people to create knowledge that transforms the future."[5] ■

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Oceans heated by volcanic ridges and seamounts

Dr Karen Bemis from Department of Marine and Coastal Sciences, Rutgers, The State University of New Jersey gives a fascinating explanation of how oceans are heated by volcanic ridges and seamounts

Have you ever wondered what controls the temperature and the chemistry of the deep ocean? If you are interested in climate change, you should. Many factors, including dense surface waters that sink to the depths, can affect the deep ocean temperature and chemistry. One of the most surprising and spectacular controls on deep ocean temperature and chemistry are the volcanic hot springs that line the mid-oceanic ridges and cap seamounts providing chemosynthetic energy to support fantastic ecosystems. These hot springs transfer sufficient heat and chemicals into the ocean to affect the deep ocean circulation patterns, the ocean chemistry (for example, the dissolved Fe content), and the biomass productivity of the ocean. [1]

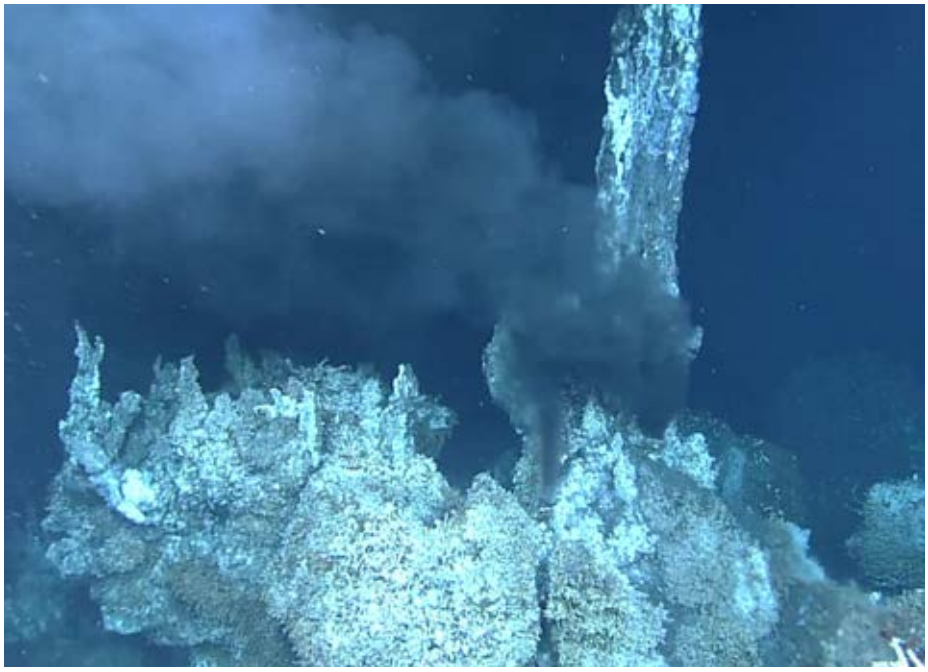

Figure 1. Black smoker on top of Grotto vent in the Main Endeavour Field on the Juan de Fuca Ridge. Video frame taken on July 9, 2011, at 04:41 GMT courtesy of Ocean Network Canada

In volcanic systems under the ocean, seawater infiltrates deeply into the fractured crust warming up due to heat from magma and reacting with the crustal rocks. This altered hot seawater rises back to the seafloor forming hot springs. Some of the hot water forms and exits from sulfide chimneys, creating rising plumes. Other hot water mixes with cold seawater below the seafloor and exists through cracks in the seafloor and porous sulfide deposits forming lower temperature distributed deposits and supporting extensive communities of microbes and animals.

Measuring the heat flux transferred by such fluids is critical to both understanding how seafloor hydrothermal venting works and to quantifying the amount of magmatic heat transferred into the ocean over time. [2] The Cabled Observatory Vent Imaging Sonar, known as COVIS, detects and measures such fluxes and their spatial distribution using a multi-beam sonar from a stationary platform to measure backscatter and phase variations within a 3D volume. [3]

COVIS emits sound which is scattered by particles and rapid turbulent changes in temperature; COVIS records the amount and locations of back-scattered sound. Because COVIS is a multi-beam instrument, each ping of sound covers a fan-shaped area; mechanical rotation is used to control the orientation of the fan. This results in information on the amount and phase of backscattered sound from every point within a 50m x 50m x 50m volume, creating an image of plumes rising from hot springs within that region of seafloor. Detailed waveform information is combined with the observed plume geometry to infer vertical variations in rising speed and the overall heat transferred. COVIS also operates in an alternate mode which produces a map of hot spring incidence on the seafloor over a 50m x 50m area.

In 2010, a joint team of scientists and engineers from Rutgers, The State University of New Jersey, and the University of Washington worked with

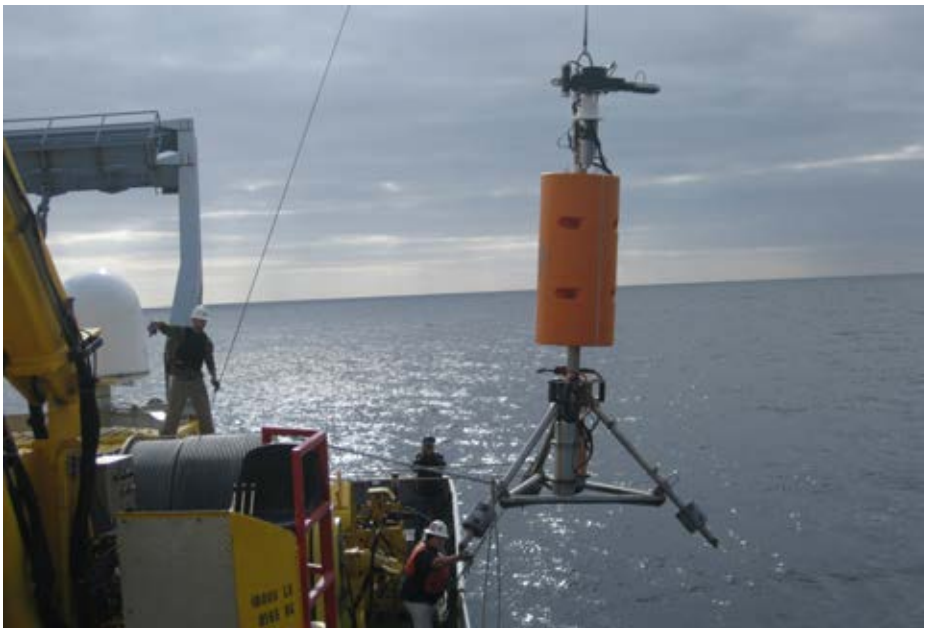

Figure 2. COVIS was lowered into the ocean in September 2010 over the Juan de Fuca Ridge from the R/V Thompson. Photo taken by Peter Rona who headed the project until his death in 2014

Ocean Networks Canada to attach COVIS to their underwater cabled observatory which extend to sites on the northern part of the Juan de Fuca Ridge, more than 100 km off the coast of British Columbia. [4] From 2010 to 2015, COVIS monitored the heat transferred by a small hydrothermal vent called Grotto Vent. During this period, the average heat transfer rate of 20 MW changed little reflecting the very low rates of even tiny earthquakes. [5] Researchers suspect that heat transfer rates would be higher during times of greater earthquake or volcanic activity.

After extensive refurbishing, COVIS is soon to be installed in a new location for monitoring heat from seafloor hot springs: COVIS will be connected to the US National Science Foundation's Cabled Array node in the ASHES vent field in the caldera of Axial Volcano, which erupted in 1998, 2011 and 2015. [6] The COVIS scientists and engineers are hoping to observe changes in heat and the distribution of hot springs during a volcanic eruption.

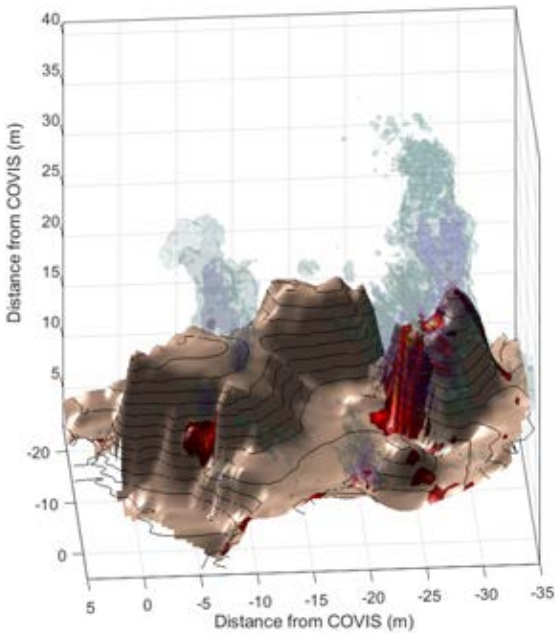

Figure 3. Example image from COVIS data at noon on Oct. 22, 2012. Blue-green colours highlight the plumes rising above the seafloor (light brown) while yellow-red-blacks highlight areas of intense diffuse output. Black lines are lines of constant seafloor depth. All distances (and heights) are relative to COVIS's location. COVIS data downloaded from Ocean Networks Canada; bathymetry from Dave Clague at MBARI

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Sweden: Developing the sustainable energy solutions of tomorrow

Sweden's Minister for Policy Coordination and Energy, Ibrahim Baylan talks to us about his government's priorities for developing the sustainable energy solutions of tomorrow

In this special interview, Sweden's Minister for Policy Coordination and Energy, Ibrahim Baylan details his government's priorities for developing the sustainable energy solutions of tomorrow. In our discussion with him, he details Sweden's plans for future investments in clean energy and how the Clean Energy Ministerial (CEM) aims to accelerate the global rate of energy efficiency improvement and increase both the volume and accessibility of sustainable energy.

"Sweden aims to become one of the first fossil-free welfare societies in the world. That is a major task, but I believe it is possible. For the first time in world history, we have the technology to provide our homes and businesses with energy in a way that does not destroy the climate and at the same time, creates new jobs and contributes to growth."

In addition, the Minister explains the aspects of energy where he thinks that international collaboration would be beneficial, such as smart electricity grids, electric vehicles, energy-efficient products and the management of the increasing share of variable energy sources in electricity grids. Finally, the Minister explains his thoughts on where he sees Swedish energy policy heading in the future.

What are your government's priorities for developing the sustainable energy solutions of tomorrow, in light of the Clean Energy Ministerial (CEM) and the Mission Innovation Ministerial (MI) parallel collaborations?

First of all, all countries need to transform their energy sectors. The energy sector is at the centre of the climate challenge – this sector accounts for two-thirds of the Earth's total greenhouse gas emissions.

To be able to transform the energy sector, I believe it is important that we not only focus on sustainable production of energy, but also scrutinise its use. As an example, we know that in Sweden, we could cut our electricity consumption from lighting by 50% if we switch to modern and efficient lighting products.

What are your priorities for future investments in clean energy?

In Sweden, we have reached a long-term political agreement for 100% renewable electricity production by 2040 and to use our energy 50% more efficiently by 2030, compared to 2005. We are also aiming to become one of the first fossil-free welfare nations. All of the actions taken by the energy policies in Sweden aim towards achieving these targets.

Within the last year, The Swedish Government has, for example, expanded our green certificate system with 90% more TWh and we have suggested new legislation for the country's hydropower production.

Going forward, we will focus more of our attention on the user side of the energy sector. With new technologies and services on the usage, distribution and storage of energy, I believe that we can go a long way towards sustainability.

Tell us how the Clean Energy Ministerial (CEM) aims to accelerate the global rate of energy efficiency improvement and increase both the volume and accessibility of sustainable energy?

Clean Energy Ministerial (CEM) is a global forum to promote policies and programmes that advance clean energy technologies. We share lessons learned and

Image: © Kristian Pohl/The Government Offices

Ibrahim Baylan, Minister for Policy Coordination and Energy

best practices, while also running technology programmes and campaigns. The countries who are partners in CEM account for approximately 90% of the world's clean energy investments and 75% of global emissions. What these countries do matter.

Can you detail the areas where international collaboration would be beneficial, such as smart electricity grids, electric vehicles, energy-efficient products and the management of the increasing share of variable energy sources in electricity grids?

Collaboration is key when transforming the energy sector in such areas. We need collaboration between public and private actors, as well as between countries. At the same time, there is no "one size fits all", so when we learn from each other and share technologies, local adaptation is often required.

The transport sector appears to be one of the most difficult areas to solve when it comes to decreasing pollution. Not all solutions are in place here yet. Research and technological developments are, therefore, needed for energy-efficient transportation, new fuels and electrification.

> "In Sweden, we have reached a long-term political agreement for 100% renewable electricity production by 2040 and to use our energy 50% more efficiently by 2030, compared to 2005. We are also aiming to become one of the first fossil-free welfare nations. All of the actions taken by the energy policies in Sweden aim towards achieving these targets."

Finally, in terms of Swedish energy policy, where do you see it going in the future and what are your government's priorities for it?

Sweden aims to become one of the first fossil-free welfare societies in the world. That is a major task, but I believe it is possible. For the first time in world history, we have the technology to provide our homes and businesses with energy in a way that does not destroy the climate and at the same time, creates new jobs and contributes to growth.

The targets we have set up in government demand a great deal of us politicians, as well as all actors in society. We need wise, forward-looking decisions and we need to be prepared to invest in new and innovative solutions. ■

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How district energy contributes to smart cities

NODA Intelligent Systems discusses how district heating and cooling systems are cost-effective solutions that contribute to developing smart cities

Around 66% of Earth population will live in cities in 2050 while in 1950 was 30%[1]. This foreseen evolution of human settlement has the challenge of keeping the COP21 agreement adopted in December 2015 in Paris by 195 members of the UN Framework Convention on Climate Change. This mainly consists of providing a framework for combating global warming worldwide with the key objective of limiting the rise in global temperature to below 2ºC. In that sense, cities will need to improve its efficiency in resource consumption and use of urban services.

One strategy of several cities around the world to face this challenge is to evolve to become smart cities. What does it mean? A smart city is an urban development vision that integrates connectivity between infrastructures, facilities and citizens by means of data-driven solutions to manage needs of urban areas. The main objective of smart cities is the use of information and communication technology (ICT) to improve quality of life of citizens and to provide real-time response to challenges[2].

The smart city is a broad concept that aims to empower citizens to interact with its environment, to create community between cities and the public government, to promote fun activities, to improve mobility and security, to foster tourism, to provide health service, to contribute to developing low-income sectors, as some examples. However, there are some detractors about the benefits of the smart city concept, related to the fact that smart technologies could be used in a way that infringes upon people's privacy[3].

Despite this wide concept of a smart city, one specific challenge that cities are facing today is how to manage the increase of population, global warming and the rise of resource demand, as well as the need of security in energy supply. In that sense:

- Transport has to be decarbonised, improving urban flows using sensors and communication and reducing emissions of vehicles.
- Lighting infrastructures have a large potential for energy savings by use of ICT.
- Energy refurbishment of existing buildings has maximum priority including building structure and heating and cooling supply facilities. Buildings account for over one-third of total final energy consumption and equally important source of CO_2 emissions.
- Infrastructures of energy supply, power grids and district heating and cooling networks, must be cost-effective and sustainable energy systems, where fossils fuels can be massively replaced for a solution with lower carbon impact.

To be more concrete, this article focuses on how district energy or district heating and cooling networks (DHC) as a part of smart cities, are crucial infrastructures to decarbonise cities, by means of generating new business opportunities and economic growth.

In comparison with individual systems on each building or apartment, DHC systems have several advantages that permit the creation of cost-effective solutions to develop urban areas, thus minimising carbon emissions:

- High capacity chillers or boilers placed in centralised facilities perform with better efficiency than individual small capacity systems.

- Waste heat recovery can be implemented in central plants, for instance, by taking profit of cogeneration plants, waste heat from solid urban waste treatment plants or industrial parks, data centres, malls or public transport stations.

- The use of renewable energy source (RES) by means of highly efficient technologies, such as biomass, biofuel, solar thermal energy or geothermal energy can be used, also reaching 100% RES coverage.

- Thermal storage systems can be implemented in DHC in a more efficient way and higher capacity than in individual systems. In the same way, heating and cooling networks are virtual storage systems themselves. Innovative district heating & cooling network controllers such as NODA Smart Heat Grid, will increase the use of waste heat and renewable energy sources and boost energy efficiency at a district level. The real application of these solutions is demonstrated in the H2020 STORM project. (https://storm-dhc.eu/)

In a distributed energy system, where penetration of renewables into the grid is very high (expected to grow 30% from 2014 to 2020[4], DHC infrastructures can be used as thermal storage to move the thermal energy production by heat pumps, electrically driven, shifting demand over time. In that sense, heating or cooling can be generated by efficient heat pumps driven by photovoltaic or wind farms when a renewable resource is available.

Another suitable technology to reach 10% RES in DH is the combination of biomass and solar thermal energy. Biomass boilers reduce its efficiency during summer time when demand is only required for domestic hot water and not for space heating. In this season, biomass boilers can stop most of the time and the energy can be obtained completely from the solar thermal field.

Nowadays, networks are designed to minimise losses. They include high-performance insulation with the optimised piping flow to reduce frictional losses. Besides that, they are designed to use lower temperatures to reduce heat losses. This feature is suitable for refurbished or new nearly net zero energy buildings (low heating/cooling loads)[5].

Traditionally, some DHC base their business model on selling as much energy as possible. However, since the oil crisis in 1970's when policies about energy efficient were a key component for reaching low carbon societies, the business of DHC in several countries is evolving towards highly efficient technologies. In that sense, the added value of a business is based on optimisation of the operation of plants, accurate maintenance and proper design to fit the energy demand avoiding oversizing plants and pipes.

In that sense, online access to buildings of smart cities will contribute to developing the optimal design of DHC infrastructures to maximise energy efficiency and to reduce greenhouse emissions. Knowing social patterns and behaviour related to energy use, together with the availability of renewable energy, these factors will drive towards an appropriate level of energy management that is suitable to cover citizens' needs, with the lowest impact to the environment.

To sum up, district heating and cooling systems are cost-effective solutions that contribute to developing sustainable energy cities with low carbon emissions. These infrastructures permit to reuse waste heat and to increase the penetration of renewable energy source in urban environments. The centralised management of energy, with customer interaction by means of intelligent digital solutions in a smart city, is a great combination to optimise the energy use and to enhance the creation of decarbonised urban places.

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A call for innovation in food production

An eco-friendly food production and healthier food will save the world in the view of horticulturist at the Swedish University of Agriculture, Håkan Sandin

Modern food production has two very negative effects on humanity. Firstly, it negatively affects our environment on a large scale. Secondly, it affects human health negatively on a large scale.

On the one hand, we have to start reviewing our food production and supply systems. It concerns all production in the world. We need to tackle the problem out of a system perspective because the problems are enormous and interconnected worldwide. However, it is not especially costly for humanity to correct what is wrong, but it is difficult and it will take time. It also needs a lot of hard work and innovation.

> "It is very strange that modern agriculture is allowed to burden peoples' health and nature to the extent that it actually does when in many cases, there are alternatives."

On the other hand, the paradigm shift is already here. Therefore, there is hope because much of the world's food production is still small-scale and is based on thousands of well-proven production methods. Modern agriculture has proven over and over again that it is harmful to nature and in fact also for humanity. One example is the rich rice production landscape in Thailand (big in size as half of Sweden), which contains so much more than just rice production. It contains fish, fruits and berries, lots of green leaves, spices, animals, frogs, insects, you name it, all kinds of food. You should not underestimate the vast knowledge of the inhabitants of this ecosystem.

An ecosystem of the food supply that is rapidly changing and becoming dependent on fertilisers and chemicals, is poisoning a thousand-year-old agro-ecosystem. The peoples of this ecosystem and their knowledge of how to produce different crops and how to prepare them for consumption, keeping themselves healthy with the help of medicinal plants and other ingredients they find in the landscape. We are talking about the integrated biological production of food, a system whose task is to keep people and nature healthy.

It is understandable that we have to change our ways of living, simply because that is what people want, that is moving to cities for a better and more exciting life. But in this process, we have to learn from the old ways of surviving, which also means how we keep ourselves healthy.

Circular, sparse and mutualistic production systems

Integrated biological production, taking into account the full value chain, is the new invention. The old production systems were circular. Everything you produced was consumed where you lived, at least to a greater extent. Now, when we are moving to the cities we have to invent ways and means of producing in them, that is new production systems that are circular, sparse and mutualistic.

Innovations of all kinds are, therefore, necessary. They must be guided by the

idea of making them circuit-based, sparse and mutualistic, thus, we can use all residual streams and resources. This applies to the entire value chain with primary production, transportation, processing, consumption and waste disposal, worldwide. In addition, food production and supply chains are the most energy consuming business in the world.

By scientifically studying these value chains, that is designing them from the start, so that we can take full advantage of all flows and reuse energy, organic matter, water and also utilise the surrounding resources of infrastructure and nature. This way, we will be able to create resource efficiency that strikes everything we know of today when producing food. This is a paradigm shift.

This development that has begun in Sweden and maybe also in other countries, will create a multi-billion industry, new primary production of food and food processing, energy supply innovations and a diversity of other innovations in urban areas. This will, in the end, create a circular, economical and mutualistic competitive industry for the production of food, where people live.

Healthy food and environment

The development is necessary because of the negative impact of large-scale agriculture on human health and environment. These negative effects are costing society in terms of the enormous amount of resources being used.

A single person who is ill due to poor food or poor consumption habits costs Swedish society 1 to 2 million SEK per year. Bad eating habits are one of the most common causes of disease. These people are, during their lifetime, increasingly ill for more than ten years. Therefore, we need to review what we produce and how we do it, all to reduce the harmful effects on human health and environment. We also have to continue the work at hand, by changing peoples consumption habits and their views on what to eat. Harmful production has to be prohibited.

Part of the solution

Designing "food parks" close to the city or producing food in the city is part of the solution. Especially if we are performing the production in-house in a completely closed recirculating mode, in strict accordance with European environmental legislation.

It is very strange that modern agriculture is allowed to burden peoples' health and nature to the extent that it actually does when in many cases, there are alternatives.

Can we save the environment when producing food?

Intensive, circular, sparse and mutualistic food production is the most important innovation of today and is part of the very obvious answer, supporting a paradigm shift. The answer, in our opinion, is yes.

- Moving production to the city whenever possible reduces the need for transport;
- Production in the city also reduces the need for production in open land and in open waters;
- By placing the production in urban areas where people live today, we can also benefit from surplus heat, electricity, organic materials, leftovers and other unused resources that need to be taken care of;
- We can also more easily employ people who are not currently in work;
- We can develop ecologically sustainable plant protection agents and systems for the protection of food crops. In-house production makes it easier and environmentally safe to use these agents;
- We can also develop ecologically sustainable fertilisers and sustainable systems for the nutritional supply of food crops! In-house production makes it easier and environmentally safe to use these fertilisers;
- We can also produce renewable fuels and lubricants using ecologically sustainable renewable materials, enabling us to create ecological safe transports;
- We can also produce feed for fish and other creatures using rest products from the city and forest industry. Producing the fish and other creatures in-house in urban areas and;
- By producing in-house, we are open to endless innovation possibilities by using high technology and ingenious solutions that the world has not seen. See the aquaponic system in Härnösand, Sweden below, as only one example of this.

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Can biofuels make Europe more sustainable?

Seb Dance MEP asks if biofuels can really make Europe more sustainable

The United Nations Sustainable Development Goals (SDGs) are a comprehensive set of commitments on a whole range of social and economic issues including energy, environment and climate change. Despite international support, they still do not enjoy the high profile of other global agreements such as the Paris Climate Agreement. Every European Union member state and the EU itself are signed up to the SDGs, but they remain somewhat obscure, with relatively little wider public discussion about the need for us to build a secure, sustainable future. This presents a real challenge to those of us involved in the policy making process at a European level.

European legislators still have much work to do to ensure that sustainability is central to everything that we do and our work on biofuels is a clear example of the challenges we face and of the commitment needed to find the right approach. Too often in its work to date on biofuels, the EU institutions have failed to engage in the kind of horizontal working promoted by the SDG agenda and this has contributed to a decidedly chequered record of attempts to introduce biofuels into our energy mix.

The incentives introduced a decade ago by the EU to encourage member states to decrease CO_2 emissions by moving away from fossil fuels towards biofuels ended up actually increasing overall CO_2 levels. There was widespread deforestation, land grabbing and food shortages. 'Indirect Land Use Change' (ILUC) was the term coined to describe the phenomenon of the clearing of virgin land to make way for the displaced food crops for biofuels. This outcome, of course, ran entirely contrary to the EU's aims and surely proves that first generation biofuels have no place in our future energy mix.

Image: © European Union 2015

Seb Dance MEP

I also remain far from convinced of the extent to which even second generation, or 'advanced', biofuels can play a role in our push towards much greater sustainability. Indeed, moves in the European Parliament to include the idea of high and low ILUC biofuels rather stretches the notion of an 'advanced' biofuel. This term must surely only be applied to the use of the best technology to turn waste matter and gasses into useable fuels whilst respecting the waste hierarchy. As the available technology improves, I am sure that these fuels will find a place in contributing to the decarbonisation of the European Union and it seems the European Commission certainly believes this to be the case.

"Ultimately, the EU institutions must face the reality that, to set a world leading example on decarbonisation and sustainability, we simply need to stop burning things and learn to be much more efficient with what we do use."

However, it is far from clear to what extent biofuels can ever make a significant contribution in meeting the European Commission's long term objectives on security of supply, sustainability and competitiveness. As more renewables come on-line and we move at an ever faster rate towards the widespread use of electric vehicles in the coming decade, it is entirely possible that traditional combustion-based energy will become obsolete, rendering the move from first generation to 'advanced' biofuels redundant. As an illustration, it is estimated that electric cars will reach cost parity with internal combustion cars by 2021 and there is currently no concrete evidence that production of the most sustainable biofuels could be scaled up to play a significant role in the future energy grid.

Ultimately, the EU institutions must face the reality that, to set a world leading example on decarbonisation and sustainability, we simply need to stop burning things and learn to be much more efficient with what we do use. We have seen over the last year, with President Trump's withdrawal from the Paris Climate Accord, that global agreements can often be fragile, it takes bold and continued commitment to make them work. The SDGs are no different and in the absence of leadership from the other side of the Atlantic, Europe must build a future when we generate our power from resources that are truly renewable. ■

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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

Globally, 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_2, noise and NO_x 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_2 emissions from 2020 essentially being carbon-neutral growth and a

reduction in net aviation CO_2 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_2 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_2 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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Managing the energy resources of Norway

Open Access Government profiles the work of Norway's Minister of Petroleum and Energy, Terje Søviknes, in managing the country's energy resources

In Norway, the Minister of Petroleum and Energy, Terje Søviknes, is responsible for ensuring high value creation through the environment-friendly and efficient management of Norway's energy resources. By way of background, the Minister was born on 28th February 1969, the son of metal worker and fisherman Eirik Søviknes (1939-) and shop employee Gunn Drange (1942-). He has since held a number of political positions, such as the time when he was the First Substitute Member of Parliament for Hordaland County of the Progress Party between 1997 and 2001.[1]

It is worth mentioning that the main task of the Ministry of Petroleum and Energy is to develop a coherent and coordinated energy policy. In May 2018, we learn more about the Minister's thoughts on energy policy in his opening speech at the 19th European Gas Conference in Oslo. In his speech, he explains that gas was once a second prize to oil, but today it is a premium commodity that provides nearly one-quarter of global energy needs. This is a point he goes on to explain in his own words.

Image: © MPE/NTBscanpix

Minister of Petroleum and Energy, Terje Søviknes

"Norway has a long and successful history as a producer and exporter of natural gas. In fact, last year we celebrated the 40th anniversary of the first export of natural gas from Norway which started with gas from the Ekofisk field in the North Sea through Norpipe to the terminal in Emden in Germany.

"Last year Norway exported a volume of gas which could cover the gas needs of an average British home for 112 million years."

The Minister then outlined why he believes that natural gas in general and Norwegian gas especially has a crucial part to play in the global and European energy mix for the future. In short, he says that natural gas is flexible and reliable, and as such, it is available in abundance and it can contribute towards large emission cuts in the instances when gas replaces coal. This latter point was just one of the many energy-related topics that the Minister keenly detailed.

"There is no one solution to our climate change challenge and we need to approach the challenge with a range of different measures. However, some solutions are more obvious than others. About one third of global energy demand is currently met by coal.

"In the EU about 70% of the emissions from electricity production come from coal while coal provides less than 25% of the electricity generated.

"One fast and cheap way to reduce emissions is to replace coal with gas as natural gas emits up to 50% less CO_2 than coal. This would really make an impact! The UK, the US and China have all achieved large CO_2 emission cuts by replacing substantial amounts of coal with gas. It works!"

The Minister also underlines that the flexibility of natural gas is vital for European energy supply. He then proceeds to compare renewable energy with natural gas, in his own words.

> "Norway has a long and successful history as a producer and exporter of natural gas. In fact, last year we celebrated the 40th anniversary of the first export of natural gas from Norway which started with gas from the Ekofisk field in the North Sea through Norpipe to the terminal in Emden in Germany."

"To put it simply, the production of wind and solar depends on the weather in a way that gas does not. You can have a wind power plant producing at full speed during a summer night with little demand, while the turbines can stand completely still on a cold winter day with high demand.

"In contrast, natural gas is only delivered when there is demand on the consumer side and can respond to dips and spikes in demand. While they have different properties, natural gas and renewables fit well together. Given the flexibility of natural gas, it can respond quickly on days when the sun does not shine and there is no wind.

"In this way, natural gas facilitates the introduction of more renewables into the power system."

The Minister underscores that natural gas plays vital part in Europe's energy mix, indeed, several hundred million Europeans depend on it daily. He says that due to falling production from domestic sources, Europe is increasingly dependent on imports. He tells us more about his views on this point in his own words.

"From my point of view, this is not a problem for energy security in itself. The important thing is reliable supplies, not self-sufficiency. European gas consumers have never had more sources of gas supply than they have now.

"EU security of supplies has improved as the European gas infrastructure network has been expanded with new LNG facilities, storage capacities and new pipeline interconnections.

"The best way to strengthen energy security is to continue efforts to develop well-functioning, well-regulated and competitive markets with diversified supply sources and sufficient infrastructure to move gas around."

The Minister's speech concluded with some positive thoughts, including the fact that today, Norway is the world's third largest gas exporter and has reliably supplied gas to Europe for decades and will do so for many decades to come. "We have never delivered more gas than we do now", he says.

"Norway will continue to make a significant contribution to a sustainable energy system in Europe, as a large supplier of natural gas", concludes Norway's Minister of Petroleum and Energy, Terje Søviknes.[2] ■

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Hydrogen is finally getting attention from Norwegian politicians

Green hydrogen is an important piece of the zero-emission puzzle, both in Norway and the rest of the world, according to Vegard Frihammer from Greenstat

Hydrogen has some fantastic characteristics as a zero-emission energy carrier. It has the quality of a very high energy to weight density and only emits water. It can be produced anywhere from renewable energy and will work well as a range extender in existing electrical drive lines. Hydrogen will, in combination with batteries and a share of sustainable biofuel, play an important role in the transition to 100 % zero emission transport.

Image: © BJØRN H STUEDAL

Minister Ola Elvestuen

The ever-present "battery versus hydrogen discussion" finally seems to be losing momentum, as politicians and others prefer to focus on the "fossil versus zero emission discussion", which is far more important and productive. In Norway, there are 2.5 million cars and even with a record-breaking high penetration of BEV (battery electric vehicles), counting for 22,3 % of new cars sold, there are almost 2.4 million fossil cars that need to be replaced. The need for hydrogen solutions for cars, buses and heavy-duty vehicles is both necessary and beneficial.

Hydrogen friendly politics is emerging

Despite a strong effort from the minority parties, hydrogen has, until recently, not been a prioritised issue among national politicians in Norway. This has resulted in low budgets and small-scale local initiatives, rather than national programmes. But this is finally about to change. After a smart move from the government where ENOVA, the national funding scheme, was moved from the Ministry of Petroleum and Energy to the Ministry of Climate and Environment, where a hydrogen friendly minister, Ola Elvestuen, now is the head of ENOVA, and so the future looks a lot brighter.

The hydrogen industry now has three different ministers seeing hydrogen as a part of the low carbon solution. Elvestuen will focus on green hydrogen production, storage and usage in the transport sector. The Minister of Transport and Communications, Ketil Solvik-Olsen, is also investing heavily in hydrogen. Through The Norwegian Public Roads Administration he launched the first public hydrogen ferry tender in 2017, which is to be operational in 2017. The Minister of Petroleum and Energy, Terje Søviknes, on the other hand is mainly focusing on hydrogen from natural gas with CCS as Equinor (Statoil) and other oil companies have picked up the interest in hydrogen.

From 120 in 2018 to 500 000 hydrogen cars by 2030

Currently, there are seven hydrogen stations for cars in Norway, five in the capital Oslo, one in Bergen and one in Trondheim – serving approximately 120 cars. However, during the last two years ENOVA, has released two new programmes supporting new hydrogen stations. The number of stations is, therefore, expected to grow rapidly over the next few years.

The National Transport Plan (NTP) has stated that by 2025, no more fossil cars should be sold. With a yearly sale of roughly 150,000 cars in Norway and assuming that hydrogen cars will have a rising market share from 30% to 50% in the years from 2025 to 2030,

Image: © Cecilie Bannow

Hydrogen station, Bergen, Norway

the number of hydrogen cars will accumulate to roughly 500,000 by 2030. These cars will then consume around 75,000 tonnes of hydrogen, which in turn, will require 4 TWh of renewable electric energy.

In addition to the car market, there will be a strong demand for green hydrogen in the heavy duty vehicle market, the maritime market and potentially, the airborne industry.

Both large-scale and small-scale hydrogen production plants needed

When setting up a hydrogen production plant, the question of whether to place the facility close to the consumer or the power production is raised. As the sales price of hydrogen will be a result of the production and the transportation cost, this will vary depending on the location for the consumer and for the power source.

The production price is significantly reduced by setting up large-scale production facilities, but to keep the transportation costs down, you need large consumers nearby. For remote locations with smaller quantities, local production and distribution are favourable.

Electrolysis as the end solution, but fossil hydrogen with CCS could speed up the transition

Norway has a large production of natural gas, with a yearly export of nearly 1000 TWh. For the Norwegian gas industry, hydrogen could provide a new market and even if green energy from renewable energy is the favourable solution from a climate perspective, hydrogen with CCS could boost the transition by securing stable large-scale production from existing facilities.

However, hydrogen from natural gas with CCS is only economically viable in large-scale, several hundred tonnes per day, and close to existing CCS infrastructure. This leaves room for green hydrogen to cover most of the domestic market in Norway where the typical project sizes range from a few hundred kg to some tonnes per day will be the typical project size.

Promising future if politician stay on course

The future of hydrogen in Norway is still vulnerable to political shifts, but as most parties have included hydrogen as a part of their platform and politicians, in general, are more hydrogen friendly, Norway could emerge as the hydrogen nation of Europe.

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UK electrical sector charts massive growth since 2010

The UK electrical sector charts massive growth with 410% increase in trading businesses since 2010, according to this comment piece from Swinton Business, part of insurance broker Swinton Group

Swinton Business, part of insurance broker Swinton Group, has identified extraordinary growth in the electrical industry, largely due to advancement in technology and improved government policy.

According to Swinton Business' Trends Report, which offers a detailed breakdown of business trends by industry and region, the number of companies operating in the electricity sector grew by 410% between 2010 and 2017. This includes power generation, transmission and distribution businesses.

One of the main reasons behind this rapid growth is the introduction of government schemes that promote renewable energy, such as the Feed-in-Tariff (FiT) and Renewable Obligation (RO).

Such schemes have encouraged over one million home and business owners in the UK to install solar panels and wind turbines on their premises or land, allowing them to generate their own supply of low-carbon energy. By doing this, they benefit from a fixed tariff for an agreed amount of time following installation, plus they can also sell back any electricity they don't use to their supplier.

The popularity of these schemes has resulted in an increase in the number of companies creating, supplying and installing the renewable technology required to meet the demand.

Perhaps unsurprisingly, the report found that Greater London has seen the biggest surge in electricity supply

"In the South London Borough of Southwark specifically, the number of businesses has increased from five to 90, with development being seen in more futuristic areas such as electric car charging points."

businesses overall. Companies in this sector have grown by 904%, which is 587% more than the rest of the UK. This is due to continual growth in the capital, meaning the network's capacity has had to expand. In the South London Borough of Southwark specifically, the number of businesses has increased from five to 90, with development being seen in more futuristic areas such as electric car charging points.

London's impressive growth has been followed by a rise of 388% in the South West and 308% in the East Midlands, where extra demand in the region has resulted in the number of electricity generation businesses growing from 65 to 265. Further north, Scotland has seen a 266% increase in electricity supply companies and is leading by example in renewable energy.

Meanwhile, the South East's overall growth of 264% has been driven by the exponential rise seen in West Berkshire. Here, the number of electricity generation, transmission and distribution businesses has grown by 1,800%, from 5 to 95.

Similarly, in Yorkshire and the Humber, the overall increase of 184% in electricity supply businesses has been fuelled by large-scale developments in the East Riding of Yorkshire, where there has been a huge growth of 900%.

Image: © Stargatechris | Dreamstime.com

Single offshore wind turbine part of a larger wind farm at Cambois beach, Blyth, Northumberland.

In the North East, numerous large wind turbines have been installed off the Northumberland coast – this has resulted in a 107% increase in electricity supply companies in the area.

Looking to the future, the battery-storage market is expected to see further growth. This will allow home and business owners to store the electricity they generate for the first time. ■

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First EU TF Magnet undergoes cold testing

Fusion energy: Making history

Laban Coblentz, Head of Communication at ITER explains his thoughts on how history is being made when it comes to the exciting world of fusion energy

Last November, the ITER fusion project – 35 countries collaboratively building the most world's most complex machine – reached the 50% mark in "total construction work scope through First Plasma." Nearly 800 publications and media outlets in more than 40 countries hailed this milestone. Scientists, government ministers and industry CEOs congratulated each other on the joint progress to date.

Which feature captures the significance of this accomplishment? Is it ITER's ground-breaking science and engineering? The multinational project management required? The potential impact of fusion energy on society? Perhaps it is a combination of the three?

Part one: The science and engineering

The physics of magnetic confinement fusion is well understood. A few grammes of hydrogen in two forms – deuterium and tritium – are injected into a large, doughnut-shaped vacuum chamber. The hydrogen gas is superheated to form an ionized plasma, its atoms separated into positively charged nuclei and negatively charged electrons. At temperatures approaching 150 million °C, the charged particles are moving fast enough that when they collide, they overcome their natural repulsion and fuse. Adhering to $E=mc^2$, a miniscule portion of mass is converted to a massive release of energy.

ITER's engineering has also been largely validated in past tokamak reactors. Multiple sets of superconducting electromagnets – cylindrical, round, D-shaped and more – create an invisible magnetic cage that confines the charged particles of the plasma away from the

metal chamber walls. Only the neutrons, which have no charge, escape the plasma to convert their immense kinetic energy into heat. These behaviours have been demonstrated in smaller machines, as have most of the cryogenics, vacuum systems, robotics and power electronics in the ITER design.

What sets ITER apart is the combination of scale and precision required. Each of ITER's main magnets weighs several hundred tonnes; some have dimensions as large as 25 metres; yet the intense magnetic fields they generate must be cross-woven so intricately that charged hydrogen nuclei – sized at roughly 10^{-15} metres – cannot escape. Components so large they must be fabricated in shipyards will be positioned with the delicacy of a watchmaker.

> "The physics of magnetic confinement fusion is well understood. A few grammes of hydrogen in two forms – deuterium and tritium – are injected into a large, doughnut-shaped vacuum chamber. The hydrogen gas is superheated to form an ionized plasma, its atoms separated into positively charged nuclei and negatively charged electrons."

These extremes are driving a host of innovations and firsts, from fabrication techniques to new materials, instrumentation and tools. They are required by ITER's mission: to demonstrate the feasibility of fusion energy on a commercial scale, by creating for the first time on Earth the conditions necessary for a "burning plasma," in which the plasma heating is largely self-generated: in brief, to create a star on earth.

Part two: Multinational project management

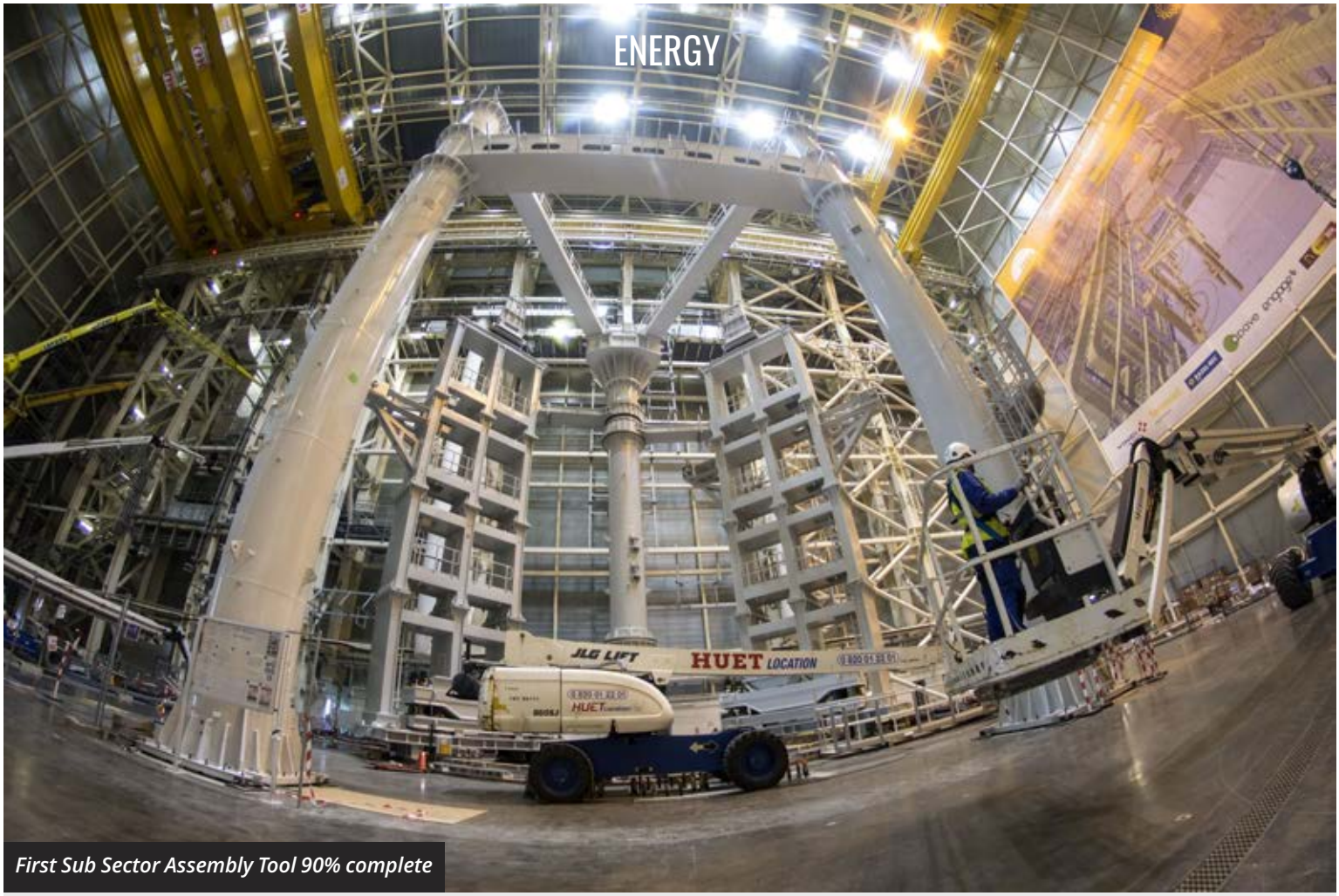
As if the complexity of a full-scale tokamak were not demanding enough, the ITER Agreement stipulates that each member will contribute most of its financial support "in-kind," in the form of hardware. In other words, the million-plus ITER components being manufactured across the globe, in Japanese factories, American laboratories, Indian foundries, Korean industrial plants, Chinese workshops, Russian shipyards, European innovation centres – must be fitted together into a single, functional device: a sort of reverse Tower of

Japanese TF Coil Case

Babel that begins with no one speaking the same language, connecting through the common vocabulary of mathematics, physics and three-dimensional CAD drawings.

Yet this is not lunacy. As the ITER Director-General, Bernard Bigot, said recently: "No country or organisation could do this alone. By choosing to build this machine in an integrated way, we have made our success interdependent. Our project is built on this condition: if our partnerships perform well, each partner contributes its expertise, we all learn from each other, the interfaces are well-managed, the project succeeds, and everyone wins." Multinational project management at ITER – systems engineering, risk management, configuration control – is a herculean effort; but in this crucible, new models for cross-border collaboration are being forged.

Consider one example: In December 2017, Japan celebrated the completion of ITER's first toroidal magnet case: at first glance, merely an oddly shaped, giant piece of steel. But the devil is in the details: the 16-meter case, fabricated in sections by Mitsubishi and Hyundai, successfully achieved tolerances of less than 1 millimetre. In January it was shipped to Italy, where a 310-tonne magnet, containing more than 5 kilometres of niobium-tin superconductor manufactured in China, Europe, Russia and the United States, will fit snugly into



First Sub Sector Assembly Tool 90% complete

the case. When finished, the component will be received at the ITER worksite in southern France, where an 800-tonne, Korean-made assembly tool – standing 10 stories tall, arms outstretched like a mechanical angel's wings – will cradle it gently, together with a European-made sector of vacuum vessel and a Korean-made ultra-thin silver-plated thermal shield; and will slowly, ponderously merge the pieces together to form a single, unified tokamak section.

To quote Bigot again: "The future of fusion – like the future of science – is partnership." Almost from its inception, magnetic confinement fusion has been uniquely collaborative. In 1968, when Russian scientists announced that their T-3 Tokamak had achieved plasma temperatures of 10 million degrees, their next action defied precedent: they invited a team from the United Kingdom, their Cold War enemies, to work with them at the Kurchatov Institute to verify and build together on this breakthrough. From that point forward, fusion has been a globally collaborative R&D effort.

This is the genius of ITER: the study of a controlled burning plasma is the convergent next step in the fusion roadmap of every country involved. Gargantuan, audacious, hellishly complex, yet elegant in the simplicity of its civilisation-changing goal: ITER seeks to enable the human animal to harness the power of the heavens. Safe, environmentally friendly and with abundant supplies of fuel available to every country, fusion energy aims to transform the socio-political landscape.

The stakes are high for humankind. ■

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Physics: Plasma-Jet-Driven Magneto-Inertial Fusion (PJMIF)

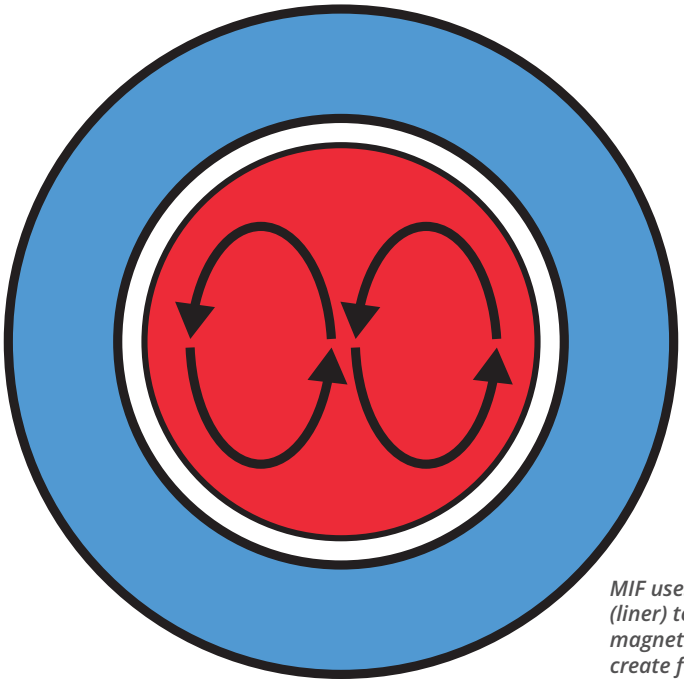
Professor Y. C. Francis Thio and Dr. F. Douglas Witherspoon of HyperJet Fusion Corporation, USA share their expert views on physics, with a focus on Plasma-Jet-Driven Magneto-Inertial Fusion (PJMIF)

In the previous article in this series[1], we reported on the plasma physics reasoning showing there is a sweet spot in the fusion parameter space with a density of the burning plasma intermediate between the two extremes typified by the two conventional approaches to fusion, namely magnetic confinement fusion (MCF) and inertial confinement fusion (ICF).

A new class of modern fusion approaches, magneto-inertial fusion (MIF), designed to exploit this intermediate density regime has emerged over the last two decades, thanks to the stewardship provided by NASA, DOE Fusion Energy Sciences (FES), DOE National Nuclear Security Administration (NNSA) and the Advanced Research Project Agency for Energy (ARPA-E).

The parameter space of MIF is very broad. MIF covers a density range for the burning plasma from 10^{24} deuterium-tritium ions per m^3 to 10^{29} per m^3. In terms of the implosion velocity, it ranges from 1 km/s to more than 100 km/s. The liner may be solid, liquid or gaseous. The many combinations of the key parameters for the target and the liners give rise to a rich and potentially large portfolio for MIF, presenting ample opportunities for innovations in the field.

At HyperJet Fusion Corporation, our goal is to develop economical fusion power, through a systematic exploitation of the broad principles of MIF, without regards to the particular choice of liners and targets. Our pursuit at present focuses on the use of hypersonic plasma jets as the main driver due to its several attractive attributes that may enable rapid progress in our quest. The fusion approach is called Plasma-Jet-Driven Magneto-Inertial-Fusion (PJMIF)[2,3]. Los Alamos National Laboratory is our partner in this development, together with several universities and institutions.



MIF uses a material shell (liner) to compress a magnetised plasma target to create fusion reactions.

In PJMIF, a magnetised target plasma is first formed at the centre of an otherwise vacuum spherical vessel. A spherical array of hypersonic plasma jets, up to perhaps 600 in total, with velocities up to about 100 km/s are launched from the periphery of the vessel, which has a radius of about 3 m. The plasma jets merge at a radius of about 1.5 m to form a plasma liner that continues to converge towards the centre and compresses the preformed magnetised target plasma down to a diameter of approximately 1 cm when fusion burn occurs in the target. The fusion burn lasts for about 0.3 μs resulting in a micro-explosion and a burst of energy. Because the efficiency of the plasma guns may be as high as 50% or more, the fusion gain needed for a practical fusion power plant may be as low as 20 or less. A thick liquid wall (FLiBe for example, approximately 1 m thick)

contained between two concentric spherical walls is used as a blanket to absorb the fusion neutrons, transforming their kinetic energy into heat and to breed tritium by an exothermic nuclear transmutation to feed the fusion reactor. The liquid wall also serves as a coolant in a heat exchanger to extract the heat from the fusion reactor to generate electricity. Each pulse of the fusion burn produces about 500 MJ of energy. If the pulse is repeated at 1 Hz, approximately 500 MW of average thermal power is produced. Because the cost of recycling the plasma guns and the first wall is relatively low, the PJMIF reactor vision allows for the guns and the first wall to be replaced and recycled after approximately every 20 million shots (~7 months)[4].

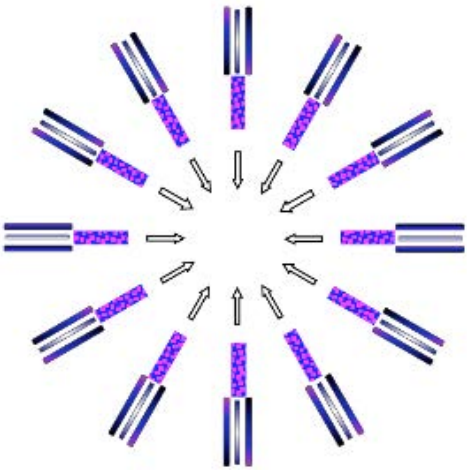
Why are plasma liners and PJMIF among other choices of liners (solid, liquid) and drivers (z-pinches, lases) for MIF?

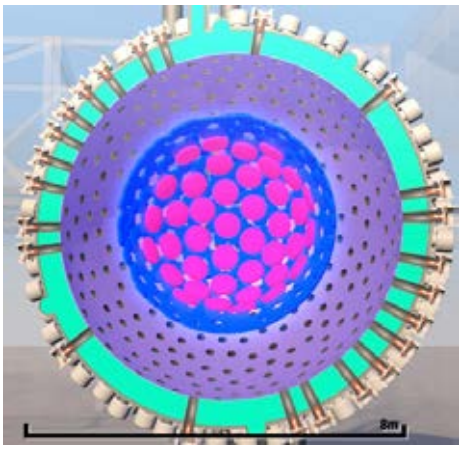
Solid-liner MIF typically employs a hollow cylindrical aluminium shell with a diameter of ~10 cm, thickness of ~1 mm and ~30 cm long. The advantages of the solid liner are that the technology of imploding a solid liner is relatively matured, the liner is extremely compact and has a high Mach number and the implosion can be made to follow a low adiabat, leading to high hydrodynamic efficiency. With a modest a radial convergence, the implosion is also hydrodynamically stable.

However, the solid liner is imploded at a relatively low velocity of about 5 km/s to 10 km/s. The implosion time is thus about 5 to 10 μs, with a plasma density of about $10^{24\text{-}26}$ per m^3. For the heating of the target plasma to be adiabatic, the timescale for the loss of heat from the target plasma (its thermal timescale) should be greater than 50 to 100 μs, which is a challengingly long thermal timescale for the density and size of the magnetised plasma targets currently known. Initial target plasma diameter much larger than 10 cm may be required to match the thermal timescale to the implosion velocity, increasing the overall cost of the reactor. Furthermore, the implosion produces debris, leading to low shot rate and high cost per shot during R&D.

Diagnostic access to the target plasma is also challenging, due to the opacity of the liner to most diagnostics. These factors tend to limit the rate of progress in R&D. Hardware destruction makes implementing solid-liner driven MIF as an economical, repetitively pulsed, commercial fusion reactor a real challenge.

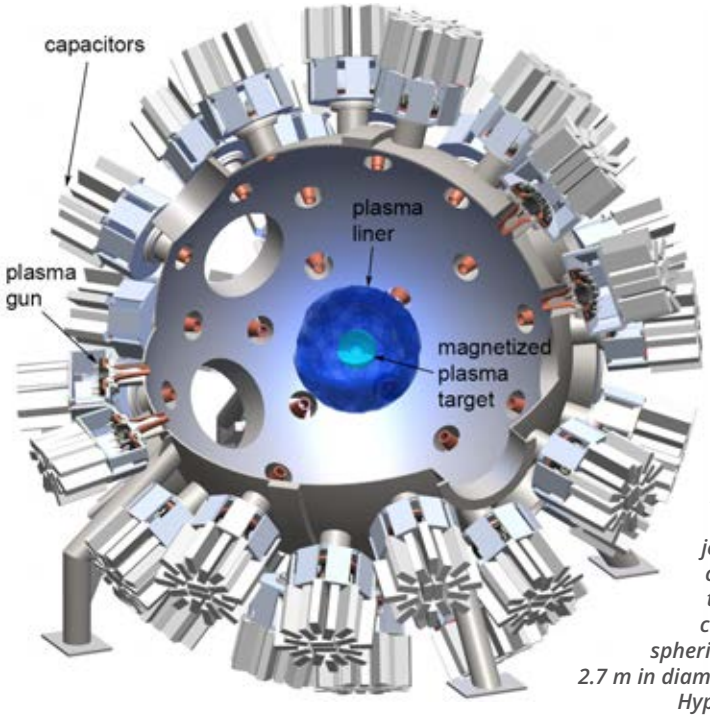
Liquid-liner driven MIF uses a liquid metal vortex to compress a magnetised target plasma. The liquid liner is imploded by pistons driven by very low-cost compressed gas in a favourably distributed configuration. The liner is non-destructive and is capable of high shot rate and doubles as a protective blanket against the fusion neutrons and a tritium breeding blanket, as well as a primary-loop coolant in a heat exchanger for the extraction of the fusion energy for electricity generation. Rotation of the liquid liner in a vortex further stabilises the implosion against hydrodynamic instability. The liquid liner is also massive and is capable of providing long plasma containment time during fusion burn. However, the implosion velocity is limited to about 2 km/s or less, even slower than in the case of the solid liner, thus requiring





an even larger initial magnetised plasma target, resulting in a larger cost for the reactor. The liquid liner directly faces the fusing plasma, creating the potential for severe disruption and a mix of the liquid vortex with the imploding plasma and as such, both may be highly detrimental to the fusion burn. Similar to the solid liner, diagnostic access to the target plasma during R&D is also challenging due to the opacity of the liner to most diagnostics. The lower density of the target plasma necessitated by its larger size may lead to plasma instabilities that cause a turbulent and anomalously high rate of thermal losses, further exacerbating the adverse consequences of the low implosion velocity.

The PLX facility at Los Alamos National Laboratory for investigating the basic physics of jet merging to form a plasma liner.



The immediate near-term objective of our research: to form a spherically imploding plasma liner (by merging 60 plasma jets) that will be used to compress a magnetized target plasma to fusion conditions. The cutaway spherical vacuum chamber is 2.7 m in diameter. Figure courtesy of HyperV Technologies Corp.

In PJMIF, implosion can be accomplished with suitably high velocity from 50 km/s to over 100 km/s with the implosion energy and momentum generated in a distributed manner. The high implosion velocity overcomes target heat loss with relatively small targets. It allows high-density targets thus avoiding plasma instabilities that may lead to anomalously high thermal losses. The plasma guns are relatively inexpensive. Like the liquid liner, it produces no hardware debris, thus enabling high repetition rate and low cost per shot for commercial fusion power plant, as well as high shot rate during R&D to provide high data rate for rapid resolution of scientific and technological issues. The spatial and temporal scales of the implosion and the open geometry allow convenient access for diagnostics. Because of these attributes, rapid progress at relatively low costs in R&D is possible. Its main disadvantage is that being the newest fusion approach, it is at a very early stage of development. Technically, the main challenges are the development of the appropriate plasma accelerators (guns) to deliver plasma jets with the required density, velocity, Mach number and precision in mass, velocity and launch synchronisation, to form a plasma liner with suitable uniformity to limit the amplitude of hydrodynamic instabilities and developing the magnetised target plasma with the required high density.

An attractive feature of the PJMIF concept is that its component technologies have near-term commercial spin-offs including the making of metallic powders for additive manufacturing, thermal spray and medical isotopes, as well as the processing of nuclear wastes.

In the next article, we will report on the state of the development of the PJMIF approach.

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Common Agricultural Policy (CAP): Helping the EU to implement Sustainable Development Goals

Commissioner Phil Hogan shared his views on how the Common Agricultural Policy (CAP) is helping to shape the EU to implement Sustainable Development Goals, during a speech he delivered on 11th May 2018 at the at German Catholic Days, Muenster in Germany

I am grateful for this opportunity to discuss the Common Agricultural Policy (CAP) and its role in helping the EU to implement the Sustainable Development Goals, including the one on Climate Action.

It is important first of all to recognise how far the policy has come. The CAP is now a modern, outward-looking policy, mindful of its responsibilities both at home and abroad.

One of the more persistent myths about the CAP is that it discriminates against farmers in the developing world by supporting EU agriculture and distorting world market prices. In fact, the truth of the matter is that over 90% of EU farmer support has zero distorting effect on trade because it is no longer linked to the quantity produced.

For many years now, our agriculture policy has been in line with overall EU development objectives. Market measures are still allowed, it is true – but only in the case of crisis and even then, price support for farmers is set at levels that are generally well below normal market conditions.

This has the effect of reducing EU surpluses and bringing us into line with global prices. Crucially, export refunds ceased to exist on 1 January 2014 and the EU was the driving force behind the World Trade Organization (WTO) decision to scrap all trade-distorting export subsidies in December 2015.

Furthermore, the CAP is now increasingly development friendly, with extremely favourable trading conditions for nations across the developing world.

Successive policy reforms of the last 25 years have seen the Common Agricultural Policy move away from coupled support tied directly to the production of particular products to supporting farmers in a way that is non-market and non-trade distorting in non-EU countries. The recent articles I mentioned have been based on an outdated and incorrect view of the CAP that in no way reflects the current EU system of support for farmers which is mainly aiming at rewarding public goods and market orientation.

> "Over the last two years, we have made continued efforts to promote responsible agri-food investments in Africa: investments which avoid land grabbing, pay a decent return to farmers and recognise their central role in the food value chain."

Let us instead focus on the facts: the reality is that the EU gives duty-free and quota-free access to all Less Developed Countries (LDCs) and unilateral concessions to developing countries. We have developed Economic Partnership Agreements – free trade agreements – that were carefully crafted to allow our partner countries to protect their sensitive agricultural products from liberalisation, either by excluding them entirely or by allowing robust safeguards that can be used to guard against sudden increases in imports.

We continue to work closely with our partner countries in the developing world to share expertise and best practice on agriculture and food safety.

People are often surprised to learn that the EU is the world's largest importer of agricultural products from Less Developed Countries.

Image: © European Union

In 2015, the EU imported agri-food products from these nations worth €3.4 billion a full 13% increase on the previous year. And we are by far the biggest supporters of farmers in Less Developed Countries: Europe imports from these countries more than the US, China, Japan, Russia and Canada combined.

Over the last two years, we have made continued efforts to promote responsible agri-food investments in Africa: investments which avoid land grabbing, pay a decent return to farmers and recognise their central role in the food value chain.

This approach also drives the global agenda at G7 and G20 level. The key common element is the focus on "facilitating responsible investments in Africa to boost jobs and growth", as well as tackling some of the root causes of irregular and illegal migration such as poverty and food insecurity.

Taking all these changes into account, I hope you will agree with my assessment that the CAP and EU policies relating to the developing world, in general, have come a long way.

Now we must look to the future.

I am fully convinced that we must complement our trade and aid efforts with improved policy cooperation with our African partners.

We need to introduce a new logic to EU – Africa relations, with political dialogue among at its centre.

We have a very good cooperation with our African Union partners and we jointly organised the African Union – EU Agriculture Ministers conference last year in Rome. This was flagged as an "example of engagement with Africa as partners".

I am very proud that in the 5th AU EU Summit which took place in November 2017, as well as in the "Abidjan Action Plan", African and European leaders have acknowledged that cooperation in agriculture will be crucial for a sustainable future.

All these events last year inspired me to use the momentum and move a step forward: I asked my Directorate General to set up an expert task force to

come up with recommendations to widen and deepen our cooperation on agriculture and food with Africa.

The overall objective is to look at job-creating economic development in agriculture and agri-business.

My idea is to bring together ten to eleven experts both from Africa and the EU on agriculture, agri-business, finance, research and sustainable production to meet regularly in Brussels and to prepare a report on this topic by January 2019.

They will work in close cooperation with the African Union which will include having some of the members of the task force come from an African farming, business and academic background.

The selection of the experts has been finalised and the first meeting of the Task Force was scheduled for 24th May. My colleague Neven Mimica, the European Commissioner for development cooperation and his services are closely involved in this exercise.

I think we have a unique opportunity to show that policy exchange and cooperation in agriculture works and provides for jobs and income opportunities. We are setting up this Africa Task Force because in my view it is the right and Christian thing to do. It will provide guidance and ideas for African countries to develop new economic opportunities. It will be a roadmap for action based on collaboration and co-operation between African and the EU.

I want agriculture to be among the first sectors where we have a successful policy dialogue between the two continents.

Of course, a key feature of this dialogue must be the impact of farming on our climate and environment.

In Europe, it is understood by everyone that farmers and the Common Agricultural Policy have a key role to play in the EU's contribution to achieving the Sustainable Development Goals. Put simply: without a central contribution from agriculture and rural areas, we will not achieve the SDGs.

The CAP and European farmers already do more than ever to promote sustainability and environmental and climate action – but we have to do even more.

In November 2017, the Commission outlined our concept for the future of EU agricultural in our Communication titled, "The Future of Food and Farming". This new

policy orientation will contribute to many of the UN Sustainable Development Goals.

I described these plans in greater detail when the Commission publishes its legislative proposal for the future CAP in late May. However, I want to inform you of two proposals that I will make: mandatory nutrient management plans and mandatory farm advisory services for farmers.

> "One of the more persistent myths about the CAP is that it discriminates against farmers in the developing world by supporting EU agriculture and distorting world market prices. In fact, the truth of the matter is that over 90% of EU farmer support has zero distorting effect on trade because it is no longer linked to the quantity produced."

We recognise that our global commitments require an ambitious move to foster a smart and resilient agricultural sector:

- We need to boost agricultural research and innovation and complementary advisory services to help farms to adopt modern technologies like precision agriculture and digital farming;

- Only with a resilient and smart agricultural sector will the EU be able to contribute to food security and improved nutrition and promote sustainable agriculture, as called for in SDG 2.

We must also enhance our environment and climate action. As stated in Sustainable Development Goal 13, we need to take urgent action to combat climate change and its impacts.

As indicated in the introductory slides agriculture and forestry are particular sectors in the context of climate change:

Farmers around the world and in the EU are strongly exposed to the consequences of climate change. Hence the future CAP will support farmers to strengthen their resilience and adaptive capacity to climate-related hazards and natural disasters.

Farmers are also contributing to global emissions. But we have seen real progress in spite of limited mitigation opportunities:

Non-CO_2 emissions from livestock and fertiliser use in the EU decreased by 20% since 1990. More can and will be done in this area through research and incentives for further mitigation action.

Farming and forestry are the only sectors with the potential to sequester carbon from the atmosphere through natural processes. Enhancing soil carbon, planting trees on marginal land, restoring and rewetting peatlands can make an important contribution to reaching our targets under the Paris Agreement.

We will also continue our actions on sustainably managed forests, to combat desertification, halt biodiversity loss and to halt and reverse land degradation, as called for by SDG 15.

To conclude, today's CAP is more development-friendly than ever before and climate and environment action will be strongly reinforced in the future CAP. ■

This article is based on a speech given by Commissioner Phil Hogan at the German Catholic Days, Muenster, Germany.

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Water, temperature and crop productivity research

Prof Robert Aiken, research crop scientist at Northwest Research—Extension Center tells us about his fascinating research into water and temperature, including the extent to which they limit crop productivity

Planting an agricultural crop requires a degree of optimism. In the semi-arid region of Kansas, which I study, water and temperature frequently limit crop productivity. These components of weather, along with sunshine and relative humidity, comprise the weather-related risks which limit the productivity of the crop just planted. As an agricultural scientist, I query the climate scientists: Are there periodic behaviours in weather patterns? Are there long-distance signals indicating wetting and drying trends? Is long-term weather forecasting feasible? If so, accurate forecasts can inform the optimism required to plant that crop, infusing an additional hope that the bet has been hedged.

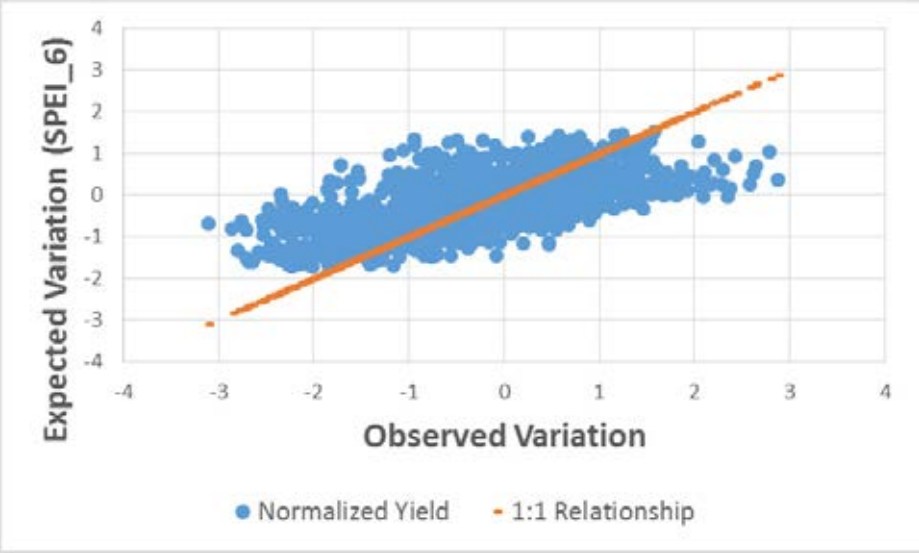

Figure 1: The in-sample predictive ability for wheat yield variation of multiple regression based on the NINO_3 surface temperatures of the Equatorial Pacific is compared against observed yield variation for wheat yield in Kansas counties W of the 99th Meridian. Observed variation represents variation after removal of a linear historic trend (1970 – 2007 period) as normalised by dividing by the standard deviation of the time series for each county.

> "There is an opportunity to develop climate-informed decision-support for cropping systems in the U.S. central High Plains."

Seeking information about weather forecasting skill, I learned about 'teleconnections' at recent American Meteorological Association meetings. The El Nino-Southern Oscillation (ENSO) phenomena serves as an example. Warming and cooling trends in the surface waters of the equatorial Pacific Ocean impact fisheries and rainfall in coastal Peru. Indeed, ENSO trends impact the productivity of winter wheat growing in the Texas High Plains. Louis Baumhardt, a USDA-ARS soil scientist and his colleagues found a degree of association between ENSO patterns and winter wheat yields in the Texas Panhandle[1]. Does this ENSO signal convey information about wheat productivity further north, in the central U.S. High Plains?

We know that winter wheat is vulnerable to drought conditions; wheat can also respond positively to wet conditions, though subject to disease impacts[2]. The Standardized Precipitation-Evapotranspiration Indicator (SPEI) provides a metric for wetting and drying conditions, generally varying between values of -4 and 4 to indicate drying (negative) and wetting (positive) conditions. We compared wheat yields, reported for counties[3] in Kansas (1970 through 2007) against monthly SPEI values, after removing linear historic trends attributed to improved genetics and production technologies.

A moderate relationship (R^2 = 0.41)[4] emerged for wheat yields reported for counties in W Kansas, indicating positive effects of weather conditions in February, March and April. A weaker relationship (R^2 = 0.25) resulted for counties in sub-humid E Kansas,

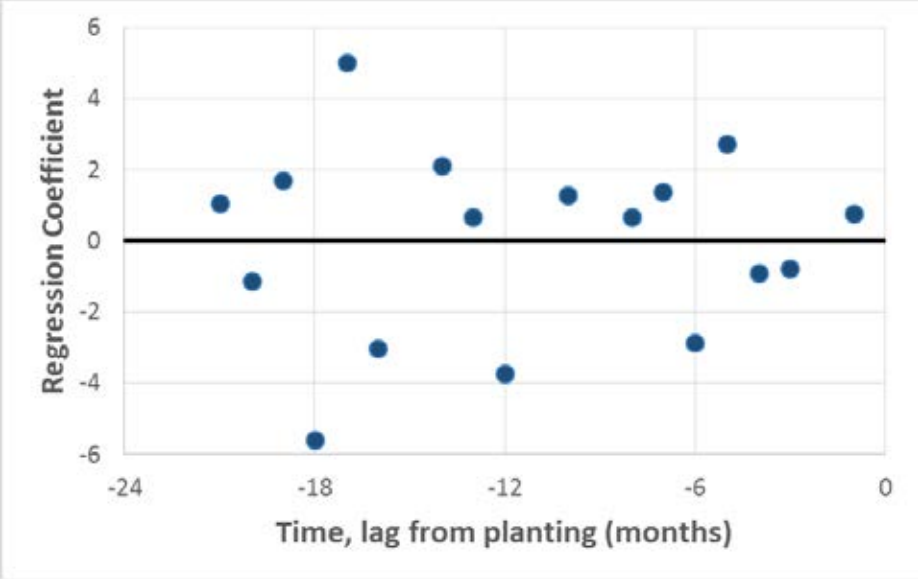

Figure 2: Regression coefficients of the NINO_3 multiple regression model is shown in relation to corresponding time lag (months prior to a September planting period for winter wheat in Kansas). Positive coefficient values for a given time lag indicate a positive association with expected wheat yields for that lag interval; negative coefficient values indicate a negative association.

indicating both positive (October, February, April) and negative (August, December, May, June) relationships with the SPEI metric. This regression analysis quantified the relationship of winter wheat productivity to weather variation during the growing season. However, the utility of forecasting skill depends on the information available prior to planting decisions.

"Are there periodic behaviours in weather patterns? Are there long-distance signals indicating wetting and drying trends? Is long-term weather forecasting feasible? If so, accurate forecasts can inform the optimism required to plant that crop, infusing an additional hope that the bet has been hedged."

Thus, we evaluated a hypothesized ENSO signal: is winter wheat grain productivity in W Kansas related to equatorial Pacific Ocean surface temperatures in preceding years? We tested the null form of this hypothesis using multiple regression for W Kansas county yield reports and monthly ENSO data for the 24-month period prior to wheat planting (September, a year prior to harvest). We found a positive result. A moderately strong relationship (R^2 = 0.53) resulted from regression analysis (Figure 1). Interestingly, the strongest influences were ENSO values 18- and 16-months prior to the wheat planting period (Figure 2). This indicates that complex patterns in equatorial Pacific Ocean temperatures can convey information which is pertinent to subsequent winter wheat yields in W Kansas. There is an opportunity to develop climate-informed decision-support for cropping systems in the U.S. central High Plains.

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3 National Agricultural Statistics Service

4 'R' squared (R2) indicates the fraction of observed variation which can be accounted for by a regression relationship.

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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

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. 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^3 $year^{-1}$ 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 $year^{-1}$ the global uptake far exceeds the safe ecological limit of 62–82 Tg N $year^{-1}$.

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 mechanistic view of the agro-ecosystem by capitalising on ecological processes in agro-ecosystems.

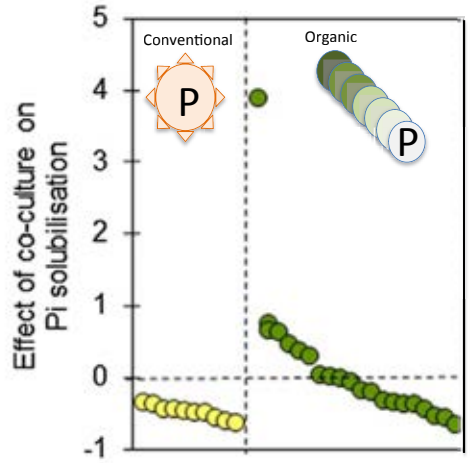

Fig. 1. The legacy of the farming system on the effect of coculture on Pi solubilisation when PSB was grown in pairs of isolates. PSB pairs resulted in significant effects of coculture on Pi solubilisation being positive (i.e. cooperation) or negative (i.e. antagonism). Symbols: yellow for combinations 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.

> "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 conventional 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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The research priorities for the cereals and oilseeds sector

Tim Isaac, Head of Arable at the Agriculture and Horticulture Development Board shares his thoughts on research into the cereals & oilseeds sector

When it comes to the cereals and oilseeds sector, there are a variety of programmes and tools AHDB has put together to enable the delivery of key objectives.

AHDB has three core research areas in cereals and oilseeds comprising:

1. Understanding the genetic potential of new cereal and oilseeds varieties, the recommended lists;

2. Understanding soil health and plant nutrition and;

3. Crop protection, to evaluate new methods of monitoring, prevention and control of crop pests and diseases.

These three areas provide outcomes in their own right, but together they provide a valuable resource for integrated crop management based on robust independent information. AHDB, through its links to the research community, growers and end users, can provide an important linkage to ensure innovative research ideas can be tried and tested for the benefit of the whole industry.

Confidence in the independent evaluation of new varieties is a good example, leading to faster uptake of new varieties with good quality benefits to the end user and better agronomic and disease resistance to the farmer.

As part of AHDB's soils research, AHDB and the British Beet Research Organisation (BBRO) announced an ambitious new research partnership to develop practical soil biology management guidance, worth £1 million. The five-year partnership looks to improve on-farm understanding of soil health by benchmarking current academic and industry knowledge, developing and validating indicators of soil biology and soil health in research trials and integrating a far-reaching knowledge exchange programme throughout the five-year programme. The £1 million project is part of the AHDB GREATsoils programme, complementing a £1.5 million initiative looking at soil structure.

In addition to longer-term research, AHDB has to be able to respond and move quickly in an ever-changing environment. Issues can suddenly occur which require a rapid response to provide new information to inform the industry across the supply chain. This may include a new disease outbreak, loss of important products, or changes in quality requirements by end users, usually as a consequence of changes in legislation.

Understanding plant pests, weed and disease epidemics, including challenges associated with new threats, resistance and a reduction in agrochemicals to manage them is a situation which requires a systems approach. Research tends to focus on individual components, which is important to understand, but the practical cost-effective solutions require a whole farm approach based on crop rotations over several years.

AHDB, with its expertise both in applied research and an understanding of growers' businesses, is in a good position to help farmers deal with future challenges.

Its Farm Excellence Platform inspires the industry to improve performance and succeed through farmer-to-farmer knowledge exchange. For the arable sector, this includes Strategic Farms, Monitor Farms, Arable Business Groups and technical events across the UK.

Monitor Farms bring together groups of like-minded farmers who wish to improve their businesses by sharing performance information and best practice around

a nationwide network of host farms. AHDB organises and facilitates the meetings for farmers, who own and operate the scheme – by farmers, for farmers. Monitor Farms also incorporate the use of AHDB's benchmarking tool, Farmbench, throughout their three-year term to track and improve performance.

A key connection between research and knowledge exchange is where knowledge gaps are identified in on-farm activity and fed back to the research community for further analysis and guidance. For example, the significant rise in interest in no-till establishment systems led to a three-month review published in April 2018 – AHDB was also able to conclude that there is insufficient evidence to change autumn nitrogen guidance for no-tilled cereal and cover crops.

Other knowledge gaps can be addressed on a farm. Some Monitor Farmers are investigating how different spring barley varieties perform under different conditions. Different varieties from across northern Europe are being grown on farms across the UK alongside more conventional options. The aims are twofold – firstly to look at the resilience of different varieties in different conditions and secondly to challenge growers to get the most out of their crops.

These are just a few examples of the huge range of work that AHDB is doing to inspire British farmers to be more competitive and resilient in light of the changes that lay ahead. They clearly demonstrate that the key to achieving this is by accelerating innovation and productivity growth through coordinated R&D and knowledge exchange.

The Agriculture and Horticulture Development Board (AHDB) is a statutory levy board, funded by farmers, growers and others in the supply chain and managed as an independent organisation (independent of both commercial industry and of government). AHDB's purpose is to inspire our farmers, growers and the industry to succeed in a rapidly changing world. Our vision is for a world-class food and farming industry inspired by and competing with the best.

This is summarised in AHDB's four core priorities:

- Inspiring British farming and growing to be more competitive and resilient;
- Accelerating innovation and productivity growth through coordinated R&D and knowledge exchange;
- Helping the industry understand and deliver what consumers will trust and buy and;
- Delivering thought leadership and horizon scanning. ■

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Genomics and precision agriculture: A perfect match for improving farm sustainability

Nicolas Friggens, coordinator of the GenTORE project at INRA, France reveals why genomics and precision agriculture are a perfect match for improving farm sustainability

The advent of genomics and its application to livestock has revolutionised breeding programmes in a number of ways. It has greatly increased the precision of animal selection and has thereby opened up the possibility of selection on complex traits. The uptake of genomics in livestock production has been mirrored by a massive increase in the use of on-farm technology to monitor animals, the so-called precision livestock farming boom.

These technologies greatly facilitate our ability to phenotype a range of animal traits – whether existing or novel in increasing detail and in large populations. Bringing these two emerging disciplines together to create real synergy and to provide on-farm tools to sustainably improve production efficiency is the purpose of the H2020 project called GenTORE, which focuses on the European cattle sector.

The cost of genomic sequencing has been steadily dropping and at the same time, the required computing power and associated bioinformatics and statistical tools to deal with genomic data have markedly improved. This explains in large part the rapid uptake of genomics in the bovine sector and especially in dairy cattle, which substantially reduces generation intervals and therefore increases selection intensity. Genomic technologies thus open the door to a wider range of traits that have traditionally been used in breeding programmes, including complex traits such as resilience and efficiency. These are the traits being focussed on in GenTORE, which stands for: Genomic Management Tools to Optimise Resilience and Efficiency.

The increasingly fine-grained description of individual genomes will allow the genetic determinism of the many components of complex traits to be characterised from relatively limited numbers of animals (thousands rather than the hundreds of thousands traditionally needed). It, therefore, has the potential to determine key genes and the molecular products they encode and, thereby, identifying new candidate biomarkers for the major physiological mechanisms underlying, for example, resilience and efficiency.

Some of the significant challenges to deploying genomics on complex traits (disentangling correlated effects from causal genes, variation between breeds in genomic associations, etc) and applying genomic prediction across multiple breeds will be addressed in GenTORE. This will enable the use of genomics, not just in multiple breeds, but also in cross-breeding – an important innovation in the context where farmers can exploit the diversity of cattle breeds within their livestock systems. GenTORE will build on this possibility by developing tools to capitalise on the genomic information available to farmers. As the cost of genomic sequencing drops, it will become worthwhile to genotype females that are to be bred. This allows farmers to choose the bulls to use in artificial insemination, on the basis of achieving a better genomic match, that is reducing unwanted recessive genes and increasing favourable gene combinations.

Precision livestock technologies have for the most part been deployed for the detection of specific health events, such as the onset of disease or for detecting reproductive events, such as heat. As such, they have overwhelmingly been used for monitoring with almost no attention paid to their possible use for phenotyping, which is a major limitation of the current precision farming approach.

Precision phenotyping offers a huge opportunity for future research into complex traits and also for future breeding and management strategies. The key feature of such technologies lies in their providing high-frequency automated measures. High-frequency measures mean that instead of having occasional snapshots of an animal's

status, for example, when examined by the vet or farmer, we have access to the whole "movie", to the evolving time-series of an animal's status (for the given measure). This allows quantification of growth, production and other life function trajectories (body reserves, reproduction, disease resistance, etc.). This information can be used to allow farmers to rank their adult animals according to not only their production potential but also to their resilience, that is their probability of reproducing and of successfully completing the next production cycle.

GenTORE will use at-market and near-market precision livestock technologies to develop proxies for resilience and efficiency. For example, using the animal as its own control, we can characterise how the animal responds to environmental perturbations such as disease pressure and variability in feed supply, not just in production, but also in body reserves and in key indicators of health status. Before the advent of precision technologies, this type of phenotypic information was very difficult to obtain with any degree of precision outside of research farms. Indeed, the major limitation for genomics is in the precision of phenotyping of the reference populations, especially for complex traits. Thanks to initiatives such as GenTORE, the data needed to allow selection on complex traits will become readily available from far greater numbers of animals, on commercial farms in widely varying environments.

It is clear that considerable synergy will arise from aligning and then combining precision livestock and genomic approaches. Developing the use of data from on-farm technologies for precision phenotyping will bring these two sectors into alignment, with substantial benefits to both. This alignment will lead to improved operational definitions of traits such as efficiency and resilience and thus open up for quantifying the relative importance of these two traits in differing production environments. Achieving this will then provide a platform for combining information on the animals' genetic make-up with time-series information on how it has been shaped by prior conditions, in the all-important context of the local production environment. Indeed, GenTORE is working to describe local production environments in terms of farming conditions, regional markets and the major environmental threats expected as the consequence of climate change. We expect to produce tools that help improve the sustainability of the European cattle sector by allowing on-farm breeding and management strategies to be tailored to the local production environment.

Given the central role of developing tools for end-users, a key criterion for the success of GenTORE is a continuing exchange with and dissemination to, a broad range of stakeholders. If you want to find out more, please check out www.gentore.eu . We are very keen to hear all of your opinions.

Video link

Nicolas Friggens from INRA AgroParis Tech, Project Coordinator for GenTORE explains the aims of the GenTORE project. https://youtu.be/fvDPqhxBm0A

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GENTORE

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The development of low-input minor cereal production systems in southern Europe

Nikolaos Volakakis of Geokomi plc and Leonidas Rempelos of Newcastle University present results from the experiments concerning low-input minor cereal production systems funded under the HealthyMinorCereals project and conducted in southern Crete, Greece – a typical semi-arid region of the Mediterranean

With cereal products being the most important source of nutrients and energy in the human diet and wheat being the most consumed crop globally, also the consumption of hulled wheat such as spelt *(Triticum spelta)*; emmer *(Triticum dicoccum)*; and einkorn *(Triticum monococcum)* has recently substantially increased. Re-introduced to the European market as 'superfoods', consumers associate spelt, emmer and einkorn with superior nutritional composition and a lower risk of wheat/gluten incompatibility symptoms compared to common wheat *(Triticum aestivum)*. As a result, hulled kinds of wheat gained widespread popularity, making their way as common wheat substitutes in artisan bread and other bakery products, pasta and breakfast cereal. Among organic farmers, they are valued for their ability to grow well under low inputs.

Spelt wheat known as *"Dinkel"* in German or *"Olyra"* in Greek cultivated since approximately 5000 BC, has been an important crop for human nutrition in many regions of Europe, from the Bronze age up to the medieval times. After the introduction of potato into Europe, it remained as a staple food and minor cereal crop in Central Europe and northern Spain. Spelt is a hexaploid wheat that can easily be crossed with common wheat in which case its botanical name used

is *Triticum aestivum* subsp. *spelta*. As a result, many "modern" high-yielding "spelt" varieties grown in Central and Northern Europe are crosses between common and spelt wheat genotypes. It is believed that varieties from these *T. spelta x T. aestivum* crosses have grain with a lower nutritional value compared with the traditional, "pure" spelt varieties.

Although hulled kinds of wheat, such as spelt were previously grown in semi-arid regions, traditional varieties have been lost since their cultivation was replaced by common wheat in most Mediterranean regions (including Greece). Hence there is no agronomic knowledge (for example, regarding optimum sowing and harvest dates, tillage/mechanical weed control, fertilisation and crop protection) needed to optimise the performance of those cereal crops in the semi-arid regions of the Mediterranean.

The research objectives of our study were, therefore, to:

- Assess the effect of fertilisers with contrasting water-soluble N and P concentrations on crop health, grain yield and its nutritional quality;
- Assess the effect of using supplementary irrigation in rain-fed winter cereal crops on crop health and grain yield/yield stability and nutritional quality parameters of grain;
- Compare crop health, yield and quality parameters in (a) traditional "pure" spelt genotypes and (b) "modern" varieties based on *T. aestivum x T. spelta* crosses;
- Identify interactions between contrasting spelt varieties and agronomic parameters (irrigation and fertilisation regimes) with respect to crop health, yield, yield stability and grain quality parameters and;

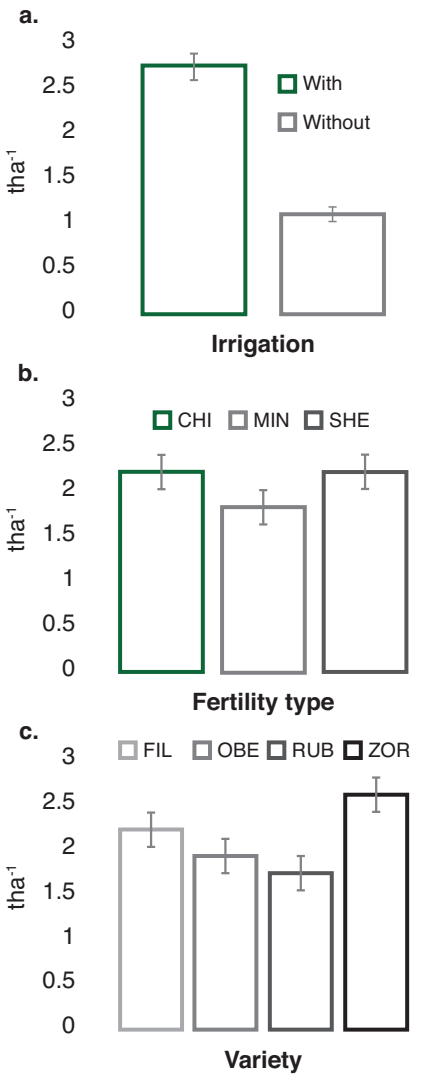

Figure 1: The effect (means±SE) of a. supplementary irrigation; b. fertility type and c. variety choice on spelt grain yield (de-hulled)

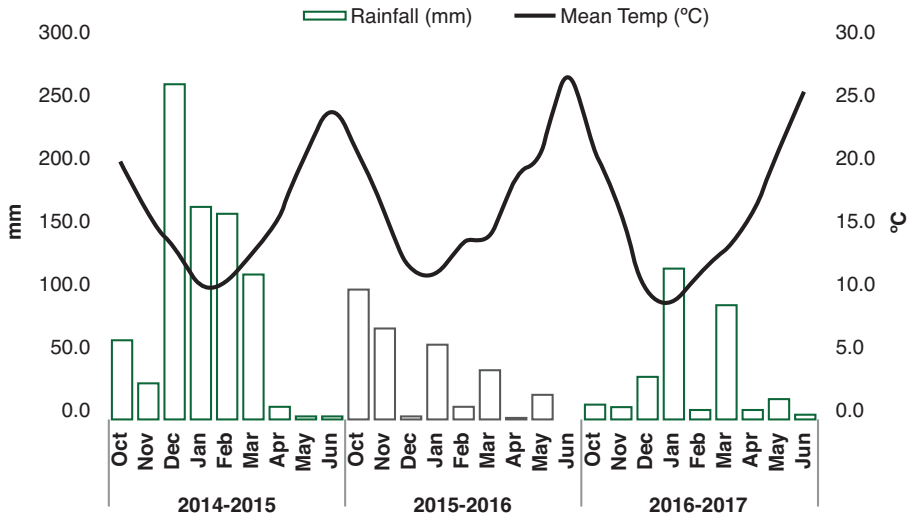

Figure 2: Monthly average temperature and total rainfall during the three years of the study

- Assess the effect of contrasting climatic conditions on spelt wheat performance.

Our results:

Irrigation: The use of supplementary irrigation was found to significantly increase grain yield (Fig.1a) only in the seasons with low winter rainfall, (2015-2016/2016-2017), while it had no effect on grain yields in the season 2014-2015 with relatively high winter rainfall (data not presented). In Figure 2 average monthly rainfall and temperatures are presented for all three seasons. Since supplementary irrigation substantially increased lodging levels (which is known to negatively affect grain quality) in the season with high rainfall, it is recommended that supplementary irrigation is only used when long-term forecasts and rainfall and/or soil moisture monitoring indicate that crops do or are likely to suffer from an insufficient water supply.

Fertilisation: Chicken and sheep manure resulted in similar grain yields (Fig.1b) and lower lodging levels than mineral NPK fertiliser. This was surprising but may suggest that under semi-arid growing conditions organic fertilisers may deliver additional benefits (for example, related to water availability and/or prevention of nutrient losses) compensating for the greater availability of N, P and K from mineral fertiliser inputs. It was found that mineral fertilisation significantly increased the protein content in grain but had no substantial impact on the mineral and antioxidant concentrations in spelt grains.

Variety choice: Modern spelt varieties (Filderstolz and ZOR) had lower lodging levels, produced higher yields (Fig 1c) but had lower grain protein concentrations than the older varieties (Oberkulmer and Rubiota). The variety choice had a substantial effect on the nutritional composition of spelt grain, especially with respect to antioxidant concentrations and activity. The modern varieties had significantly higher total phenolic acid and flavonoid concentrations, as well as antioxidant activity. Relatively small differences in mineral composition between the varieties were detected.

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Advancing open access and open data in higher education

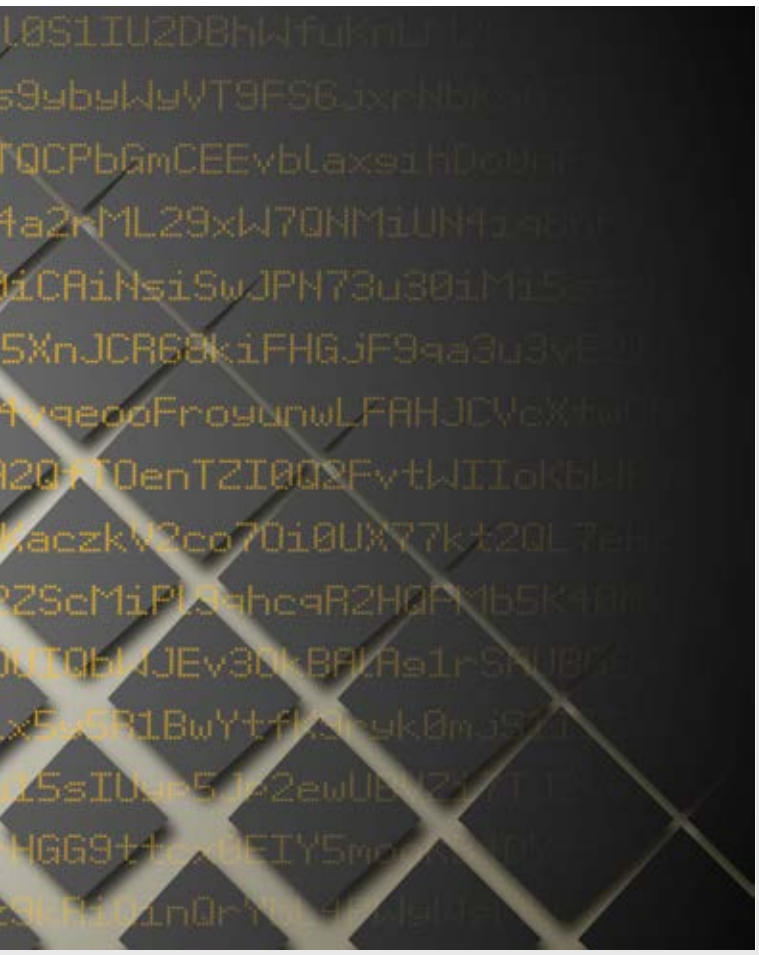
Jaime Adams and Anne Mims Adrian, PhD shares their views on advancing open access and open data in higher education

Every year, the U.S. Government provides billions of dollars to U.S. universities to conduct scientific research. In 2013, the U.S. Government began the process to increase public access to the results of research funded by the federal government, to ensure these results were made available to the American taxpayer. Opening research results may lead to many advancements, including accelerating scientific discovery, stimulating innovation, reducing duplication of effort and enhancing economic growth and job creation.

As the U.S. Government continues to fine-tune open access requirements, many universities are finding themselves at a crossroads. U.S. universities often receive funding from various sources including the U.S. Government. Many funders are instituting open data requirements, which often vary creating a very challenging situation. To explore the issue further, a consortium of universities from around the world known as Presidents United to Solve Hunger – or PUSH – conducted a study assessing open access and open data policies and practices.

> "Opportunities for new knowledge, more informed decisions, predictions and innovations are created when data collected throughout the research process are shared. Open data policies that balance the requirements from funders and researchers on standards and practices are needed for successful and effective data exchange and use."

Open data practices are currently driven by funders' requirements, yet very few universities have policies and procedures to address these requirements. Scientific



disciplines like biomedicine, veterinary medicine and pharmacy have established standards and repositories open to the research community but lack the infrastructure to freely share research data with the public.

In a recent PUSH study, no PUSH member universities have open data policies and only 15% have open access policies. Many participants believe that clarity must be given to data ownership before developing open data policies. This report, released in June 2018, also provided several recommendations to advance open data implementation to include greater alignment between funders' expectations and universities' capabilities, by including costs of sharing and maintaining data sets in project budgets and delineating standards and protocols.

In a separate Global Open Data for Agriculture and Nutrition (GODAN) study, researchers found that funders recognise that cost and lack of infrastructure and standards are preventing data to be shared in ways that are free, accessible, interoperable and re-useable.

In both studies, it is evident that there is a growing need for standards, common language (ontologies) and protocols to make data discoverable and useable. In November 2017, the Association of American Universities (AAU) and Association of Public and Land-grant Universities (APLU) released the Public Access Working Group Report committing to a set of shared principles and minimal levels of standardisation across institutions and agencies to ensure access to publicly funded research.

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Opportunities for new knowledge, more informed decisions, predictions and innovations are created when data collected throughout the research process are shared. Open data policies that balance the requirements from funders and researchers on standards and practices are needed for successful and effective data exchange and use. ■

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Woody breast: A hard problem for the poultry industry

Dr Macdonald Wick, Associate Professor at The Ohio State University's Department of Animal Sciences explains why Woody Breast is a hard problem for the poultry industry

Several decades of selective breeding have changed the genetics of chickens, with breeders selecting for faster growth, ever-increasing body weights, but more specifically, increased breast muscle *(P. major)* meat to carcass ratios (breast muscle yield). This has resulted in the generation of 'broiler' chickens – genetically designed for meat production. Optimisation in genetics and nutrition have contributed to affordable and plentiful poultry. In 2016, over 15 million metric tonnes of broiler meat were consumed in the US and nearly 90 million tonnes worldwide. However, this success has not been without costs – both for the birds themselves and consumers.

In addition to systemic challenges, these genetic and rearing strategies, have contributed to correlated increases in developmental breast muscle abnormalities (myopathies). These myopathies result in decreased consumer acceptability. The two most important myopathies currently challenging the poultry industry are white striping and wooden breast. Studies have reported a strong correlation between white striping and wooden breast. It has been argued that accelerated growth, breast muscle yield, with the accompanying impaired vascularity are predisposing factors to all three anomalies. Macro- and microscopic characterisations of white striping and wooden breast have striking similarities, including mild to severe edema hemorrhagic/inflammatory lesions and loss of vasculature (pale/yellow colour). Microscopic similarities include polyphasic degeneration, perivascular necrosis and infiltration of connective and fat tissue.

Muscle development – or 'myogenesis' – is a complex yet tightly regulated temporal and spatially specific process in poultry that begins with the embryo while still in the egg. Precursors to muscle cells, known as myoblasts, migrate and fuse together to form fibres known as myotubes, which subsequently differentiate into mature muscle fibres. The molecular/cellular mechanisms induced by the genetic selection for the increased growth ratio of a single muscle, the P. major, remains unresolved but it is likely that it lies at the root of the myopathies.

Wooden breast was first described in live broilers as extremely stiff breast muscles that could be detected by palpation. The phenotypic hardness of wooden breast is associated with varying degrees of firmness, pale colour, surface haemorrhaging and white striping. The hemorrhagic lesions and diffuse, hardened areas, when examined histologically, exhibit polyphasic degeneration, perivascular necrosis, interstitial inflammation, perivenular infiltration of T lymphocytes with the infiltration of connective tissue and fat. Hypoxic conditions limit the regenerative capacity of muscle fibres by favouring the replacement of degenerated muscle fibres with lipid and fibrotic tissue. Various potential contributing factors to wooden breast have been identified, such as localised muscular

hypoxia, oxidative stress within the affected muscle and increased levels of intracellular calcium.

Not surprisingly, these anomalies can have a significant impact on consumer acceptability, most notably through visual, white striping and textural, wooden breast, changes. With white striping, the surface of the breast muscle exhibits white strips of fat tissue. In the case of wooden breast, there is an increase in compression force and shear force using Allo-Kramer, Warner-Bratzler shear force analyses. As such, these affected breast muscles are often downgraded or even condemned. The potential economic loss due to downgrading was previously offset by the continued gains in growth and breast muscle yields and management practices which minimised the predisposition for the myopathies. Unfortunately, since the initial description of these anomalies, the industry has experienced a rapid increase in the percentage of affected broilers within a given flock, as high as 90%.

There is ample data to support an association between white striping and wooden breast, with nearly all reported cases of a wooden breast having some degree of white striping. In addition, the onset and severity of each anomaly is influenced by: Genotype (high > standard breast yield), gender (males > females), growth rate (fast > slow), diet (high > low energy), P. major breast muscle weight (heavy > light) and slaughter weight (heavy > light). Again, the cause and effect relationships underlying this association have not been reported.

Many studies are underway, using combinations of transcriptomic, proteomic and statistical modelling to elucidate the molecular mechanisms underlying poultry muscle growth and development to elucidate the molecular/cellular mechanisms of white striping and wooden breast. These studies are focused on various influences – both genetic and environmental – that affect poultry muscle development, as well as the post-slaughter conditions that directly affect meat quality with particular emphasis on meat processing characteristics.

> "In 2016, over 15 million metric tonnes of broiler meat were consumed in the US and nearly 90 million tonnes worldwide. However, this success has not been without costs – both for the birds themselves and consumers."

New information is emerging, using combined morphological and quantitative transcriptomic strategies in which the P. major of broiler chickens were evaluated for the changes in muscle-specific transcription factors and the morphology of the breast muscle every other day post hatch until market weight to elucidate the myogenic signals and proteins associated with the progression of white stripping and woody breast. The data supports the notion that white striping is a harbinger of wooden breast and that nutrition can play a role in reducing the onset of wooden breast. That is, reducing growth rates can delay the onset of myopathies.

In conclusion, the demand for inexpensive, affordable poultry meat has pushed chickens and turkeys to their physiological limits – impacting the welfare and muscular health of the birds, as well as the quality of their meat. Studies are underway in an attempt to unravel the biological mechanisms behind muscle problems in poultry. These studies will eventually lead to the establishment of biomarkers for future breeding strategies that balance welfare with the economic value of meat products.

For example, recent reports describe the macroscopic changes associated with WB ontogeny in the development of a ranking system and the contribution of growth parameters in the determination of rank wooden breast severity. Results suggest that physical measurements inherent to selection for high-yielding broiler genotypes are contributing to the occurrence and severity of both white striping and wooden breast. These studies are leading to a ranking system to describe the ontogeny of wooden breast and a model relating the rank probabilities to the severity of the myopathy, based on physical measurements during the post-hatch growth period with the potential development of an economic model to simultaneously optimise bird's welfare and the economic return of poultry operations.

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Educational philosophy and theory: Priorities and new directions for research

The editorial team of Philosophical Inquiry in Education, Bruce Maxwell, Lauren Bialystok, Kevin McDonough and David Waddington, outline their views on promising new directions for research in educational philosophy and theory

Like philosophy itself, the field of educational philosophy is notoriously difficult to define even, if not especially, for the very people working in it. Other areas of educational research are more straightforwardly delineated in terms of a characteristic object of inquiry. Researchers in mathematics education, for example, investigate matters relating to how that subject is taught and learned in schools and researchers in teacher education study the acquisition of professional competencies among new and experienced teachers.

What unifies scholarship in educational philosophy and theory is something more abstract: a commitment to a particular mode of inquiry. Philosophers of education tend to explore fundamental questions that touch on meaning, value and purpose in education and pursue the answers to such questions using the tools of critical inquiry and argumentation.

During the early years of its history as a distinct area of scholarship, expounding and developing what great thinkers of the past had to say about education was the bread and butter of educational philosophy. This orientation was largely driven by the demands of teacher education programmes, which generally considered that exposure to the "classics" was an essential part of the professional socialisation of future teachers. As teacher education has evolved in recent decades, the philosophy of education has changed with it. "Modern" educational philosophy has coalesced into four discernible thematic areas which, taken together, embrace the research activities of the vast majority of scholars who identify as philosophers of education.

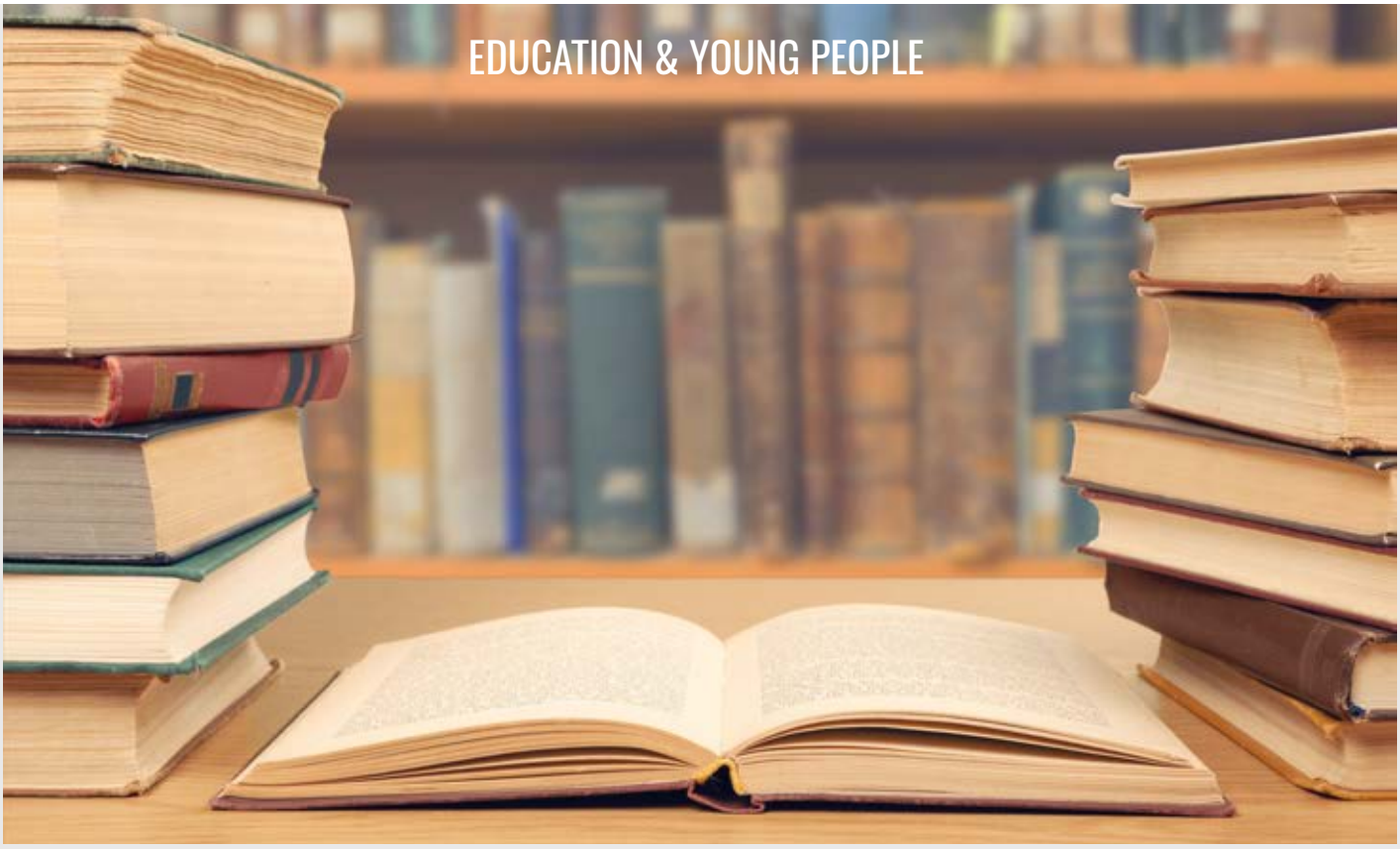
Roughly in the order that they emerged historically from the 1960s on, these areas are:

Analysis of the language of education. What began as a project to clarify fundamental questions about education (e.g., what is an educated person?) by clarifying the meaning of words, the quest for coherence in the language of education is now more likely to consist in subjecting to critical scrutiny terms that have gained currency in educational discourse (e.g., constructivism, brain-based education).

Critical pedagogy. Drawing on intellectual currents in the social sciences and humanities such as critical race theory, Marxism and postmodernism, this approach to educational philosophy applies a critical lens to educational questions to unmask forms of identity-based discrimination and other social injustices perpetrated by educational institutions.

Politics and ethics of education. Primarily concerned with how educational philosophy can contribute to public debates around policy and ethics, thinkers associated with this approach gravitate towards two broad issues: the proper aims of citizenship education in liberal democratic societies (autonomy? patriotism? civic engagement?) or the ethical analysis of policy options and other ethically laden questions facing teachers, educational leaders and parents. Such questions include school choice, banning religious clothing in schools and "zero tolerance" disciplinary policies.

History of educational thought. The philosophers of education who continue in this tradition are inclined to reinvent the history of educational ideas as a dialogue between education's past and present, either by seeking to uncover insights from the work of philosophers of the past that can shed new light on contemporary educational questions or by turning to such writings to



retrieve valuable ways of thinking about education that have been lost or forgotten.

Prognosticating about the future of any field of scholarly inquiry inevitably involves making uncertain distinctions between passing trends and stable tendencies. The philosophy of education, like other areas of the humanities, is highly subject to both occasional enthusiasms for particular authors and peaks of interest in issues determined by the ambient political climate. As editors of Philosophical Inquiry in Education, a philosophy of education journal with a deliberately open and inclusive editorial policy, we are regularly exposed to new work emanating from all four of the thematic areas described above. From this vantage point, we see two recent shifts in scholarly activity that already show signs of shaping the contours of research in educational philosophy and theory.

The first of these is assigning greater importance to public engagement. Bringing to bear a philosophical perspective on current educational issues has always been a concern in work on educational policy and ethics. However, recent years have seen philosophers of education being more pragmatic in the choice of questions to address and finding ways to write about ethical and policy issues that can make educational philosophy accessible to decision makers and educators. Two notable recent examples are Amy Shuffelton and Bryan Warnick's work on gun violence in schools and Doris Santoro's work on teacher burnout.

Paralleling a similar development in mainstream philosophy, a second promising direction for research in the philosophy of education involves a new appreciation of how the philosophical perspective can be enriched through greater integration with empirical work. In the past, philosophers of education were largely expected to engage primarily with the work of other philosophers and to eschew empirical inquiry.

Today, we find philosophers of education increasingly attentive to how appropriately designed empirical studies can complement the traditional activities of conceptual analysis and social critique. The finest recent example of this approach may be Paula McAvoy and Diana Hess's investigations into teaching about controversial issues in schools, which has won accolades for breathing new life into old debates about teacher neutrality. ■

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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 EagleWoman 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.

> "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."

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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What next for children and young people with speech, language and communication needs?

Mary Hartshorne, I CAN's Head of Evidence shares her thoughts on the report Bercow: Ten Years On and the next steps for children and young people with speech, language and communication needs

Many reports are criticised as spending too much time admiring a problem and not enough time doing something about it. In March 2018, I CAN, the children's communication charity and the Royal College of Speech and Language Therapists (RCSLT) launched the Bercow: Ten Years On report, an independent review of provision for children and young people with speech, language and communication needs (SLCN) in England. The report found a fractured system failing thousands of children and young people by not identifying their needs early enough or providing adequate levels of support.

It's not a new problem. So, if we've all been guilty of 'admiring the problem' before, now is really the time for action.

Action is needed because the findings of this report matter. They matter for the two or three children in every classroom who have developmental language disorder (DLD): a condition where children have problems understanding and/or using spoken language, but where there is no obvious reason for these difficulties – no hearing problem or physical disability that explains them. Around half of these children go unnoticed in primary schools and because good language skills underpin the ability to learn to read, to learn and to develop socially and emotionally, this can have a drastic impact. We have the evidence for this: just 15% of pupils DLD achieved the expected standard in reading, writing and mathematics at the end of primary school compared with 61% of all pupils, likewise only 20% of pupils with DLD gained grade 4/C or above in English and maths at GCSE, compared with 63.9% of all pupils. There is also a much higher risk of mental health issues in children and young people with DLD, increased risk of behaviour difficulties and language difficulties are highly prevalent in the youth offending population. But this does not have to be the case, with the right support; children with DLD can do well academically, socially and emotionally.

Mary Hartshorne, Head of Evidence

In taking action, thousands of children and young people with DLD will get this support. To, ensure that the report will not just stay on the shelf, quickly becoming out-of-date as governments come and go; there is both a 'top-down' and 'bottom-up' approach to change.

From the top, strategic recommendations demand change from national and local leadership. The report asks for systemic change, which considers the impor-

How people can act locally, to support the strategic recommendations	
Top-down	**Bottom-up**
Strategic recommendations	www.bercow10yearson.com/supportingchange
Ofsted should ensure that training for inspectors should ensure a focus on SLCN, including specific advice on how schools assess and monitor progress in the spoken language.	Use our information sheet and PowerPoint presentation for primary or secondary schools to share information about progress in spoken language and the impact of SLCN support with Ofsted inspectors.
NHS England and the Department for Education should fund a programme of training for local commissioners on commissioning for SLCN.	Use our prevalence information to share information with people responsible for commissioning SLCN support. Talk about local prevalence or about the numbers of children with SLCN in your school or college.
Local area SEND reviews should consider the evidence from this review for effective joint commissioning of support for SLCN.	Look out for your LA SEND inspection here and take up the invitation to meet with inspectors when they inspect your local SEND services. Use our information sheet for advice about questions you can ask and ideas for useful information to share.

tance of speech, language and communication in children and young people's development and asks for SLCN to be embedded within government policies. So, for example, where the government is taking steps to change mental health provision, this should recognise the link with SLCN; current plans for reforming early career support for newly qualified teachers should include training in SLCN; commissioners of SLCN services need to understand about effective ways of supporting children and young people with SLCN.

The bottom-up approach draws from the evidence presented to the review. As well as challenges and issues, the review also found many examples of innovative, effective practice. Based on these, a series of calls to action encourages everyone to take bold first steps to make change happen: school staff, early years practitioners, speech and language therapists, parents and young people themselves. Accompanying the report is a website www.bercow10yearson.com/supporting-change, which is full of practical resources: information sheets, top tips, email templates, presentations and guidance to support people in doing this.

As far as possible, the calls to action support recommendations both top-down and bottom-up – here are just a few examples of how this works:

I CAN and RCSLT have committed to reporting on progress one year on; in the meantime, there are things that you can do. You can sign a petition asking for the government to respond to the review at https://petition.parliament.uk/petitions/215643.

Visit www.bercow10yearson.com/supportingchange and find out how you can act and watch out for the progress report in 2019. ■

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Language development: Learning from what children say

Mabel L. Rice, Distinguished Professor of Advanced Studies at the University of Kansas argues that children's utterances provide valuable clues about how their language develops and hallmark areas of grammar weaknesses in those with Specific Language Impairment (SLI)

When we want to learn a certain language, we have many kinds of reference materials to consult, benchmarked to the adult language system. In contrast, children's grammar has not yet been fully documented. An important source of information in this area of study is what children say. Early studies were done by parent scientists, keeping diaries of what their child said. In 1973, Roger Brown realised the value of new technologies for recording speech with portable devices for the purpose of studying children's early language in detail; he reported the outcomes in a benchmark book[1] and established new scientific methods for recording child utterances.

Language appears late in children with Specific Language Impairment (SLI), although other developmental benchmarks follow age expectations. The causes of delayed language acquisition are unknown. The details in what children say provide valuable clues about weaknesses in their linguistic system. Informative dimensions are what they talk about (i.e., content) and the sentence structures they use (i.e., linguistic form).

For example, during the preschool years, children learn the names of colours. This can take longer than expected for children with SLI. Consider a six-year-old boy, Stevie, whose language is immature for his age. He does not know the names of colours, which is a limitation in a classroom with colour-coded spaces and signs. For example, an adult tries to teach him the names of the colours "red," "blue," "green" and "yellow," using simple blocks and toy objects and repeatedly asking "what colour is this?" This approach is pursued for several months, with no apparent success. One day, Stevie asks the adult, with genuine bewilderment, "Why you call that red?"

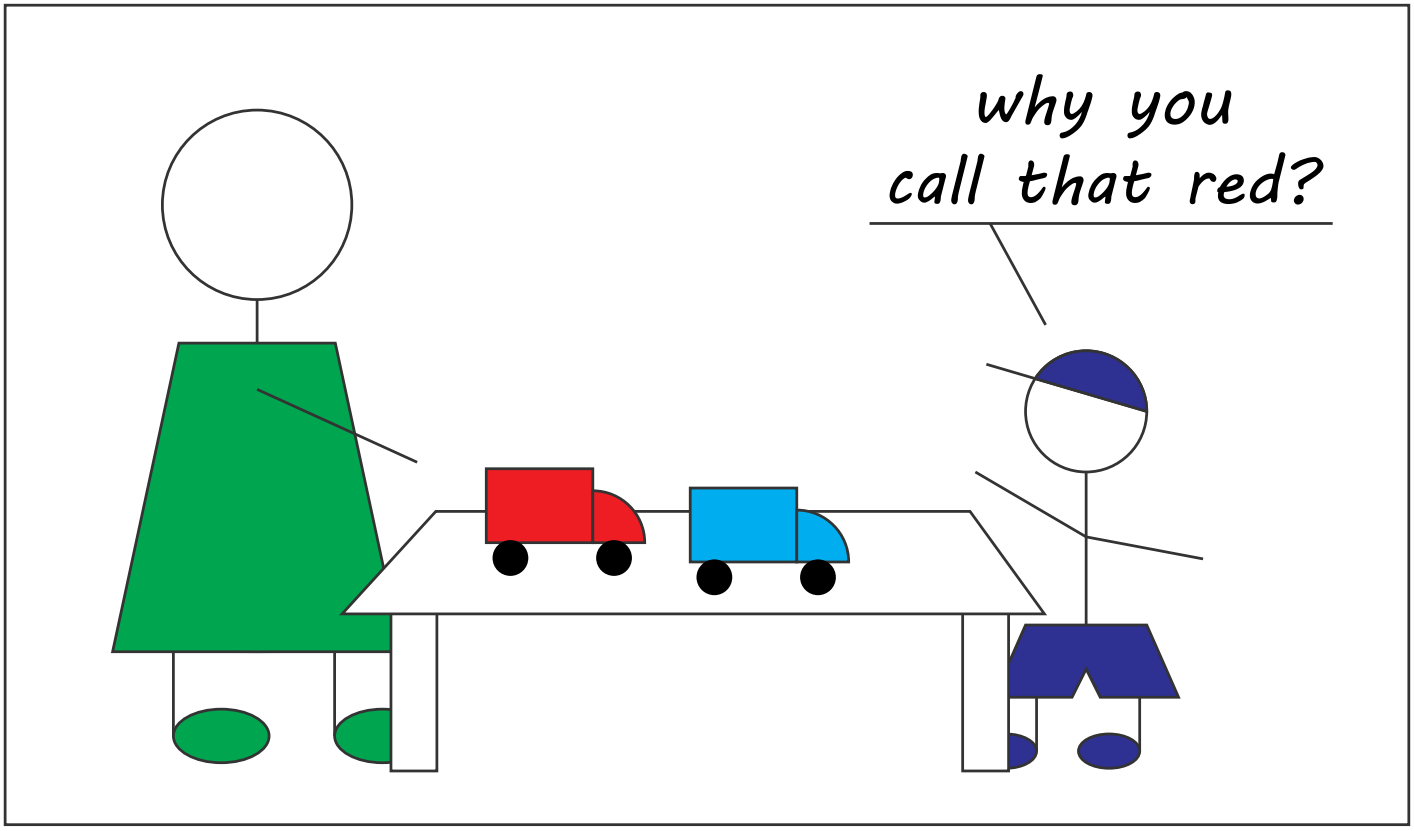
What clues are provided by his question? On the content level, Stevie is perplexed about using a word to refer to the hue of an object, or that this is a meaningful way to differentiate objects (although he certainly knows about broken objects, dirty objects and his versus my objects). Stevie subsequently works this out on his own, without continued prompting and with pride in his accomplishment.

However, his more significant problem with language is less apparent and is at the level of sentence structure. His sentence: "Why ___ you call that red?", is missing the required auxiliary *DO* (the italicised capitalisation conveys the citation form that would include the words "do", "does," and "did"). This is often thought of as a "little word" that can be omitted without hampering communication.

Although most speakers of English use the rules that apply to the use of auxiliary DO, they rarely know the structure of the underlying rules and are highly unlikely to explain the rules to their children, in contrast to the ways parents often focus on the names of colours. Instead, parents may sense that a six-year-old's grammar is "immature" if such forms are omitted, although they are unaware of exactly what is missing.

"Language appears late in children with Specific Language Impairment (SLI), although other developmental benchmarks follow age expectations. The causes of delayed language acquisition are unknown."

Advances in linguistic theory in the early 1990s identified systematic ways in which young children learn the property of grammar known as "finiteness marking"[2]. In English, a set of forms mark finiteness: Auxiliary DO in questions (but main verb DO is different grammatically), copula and auxiliary BE, past tense -ed, or a default to the citation form of the verb for irregular past tense ("run" instead of "ran") and third person singular -s, as in "walks"[3]. In the case of children with SLI, a stage of omission of these forms is likely to



persist into adolescence, long after unaffected children have mastered it[4]. This part of the grammar has served as a reliable clinical marker of children with SLI[5] with high heritability[6,7].

Stevie's question reveals the need for understanding two distinct dimensions required for language acquisition: 1. Children's conceptual development as a basis for language concepts expressed in words and 2. The ways in which grammar works with linguistic constructs such as tense marking, subject/verb agreement and word order requirements, such as the insertion of auxiliary DO in Wh- questions.

Although the meaning part may be more intuitively obvious and more likely to be overtly taught, for most children no explicit teaching is needed for learning grammar. Yet, for children with SLI, the requirement to mark finiteness is not readily learned and instead continues to be treated as optional, even though it is a required element of a well-formed sentence. Perhaps Stevie's question reminds us that the most obvious "error" is not necessarily the only error or the most important one to note. Our sense of what to notice is affected by our knowledge of where to look, even for something as commonplace as children's language.

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The decentralisation of flights in the UK from London to regional hubs

Stephen Davis, CMO at the global travel agency Kiwi.com shares his views on the decentralisation of flights in the UK from London to regional hubs

News of a new long-haul route at Doncaster Sheffield Airport and the building of a brand-new railway station to facilitate the airport has been welcomed by the travel industry in a bid to decentralise flights to and from the UK from London

The project, dubbed 'Aerotropolis', is set to generate £3.2 billion for the local economy, with airport passenger numbers set to increase to 4.7 million per year by 2037. This will have a profound impact on local tourism in the North of England, with local businesses set to flourish from the inbound tourism this will bring.

The growth of regional airports around the UK is essential for not only the growth of British tourism, but also tourism worldwide and improving the infrastructure in areas not name, London provides consumers with cheaper alternatives to flying into the capital. Any regional airport that has international arrivals will benefit hugely from an increase in business. Just think about Americans travelling to Edinburgh, or Chinese visitors to Manchester. The result is millions of additional spend on hospitality, leisure and retail. Furthermore, the growth can only help compliment HS2. That part of the UK will be more accessible to the country's residents and visitors.

Whether we'll see a decentralisation of flights from London remains to be seen, but they are positive developments.

London remains the key departure and arrival point for the UK, as we are served by five international airports (six if you include Southend) and that provides an enormous amount of choice for the consumer. But for many UK travellers, London is not that attractive. The thought of getting stuck on the M25 or M4 is starting to put people off. We have seen the growth in LCCs operating out of regional airports with Manchester, Birmingham, Leeds-Bradford, East Midlands, Glasgow, Edinburgh, Bristol and Southampton being most notable.

Stephen Davis
CMO

Additionally, many of the larger US legacy carriers and Middle East carriers operate regional services on a seasonal basis. There are reports that Delta and Virgin Atlantic are launching more UK regional departures this summer. Both Emirates and Qatar Airways operate regional services from Scotland and Manchester. Ultimately, consumer preference must be matched by airline route and network analysis. If there is sufficient demand for the route, an airline will introduce it. One thing to note: regional flying is often risky for airlines as it is only point-to-point demand and doesn't have the same passenger flow as London.

At Kiwi.com, we constantly welcome the arrival of new air routes and airline operators flying to new destinations, as it offers the customer more choice and freedom. The hope is that the opening of more routes to regional UK airports will help direct people away from London to experience the amazing cities around the UK we have to offer.

It's not only inbound tourism that is set to flourish but opens more outbound tourism from the UK. There has been a 69% increase in regional flight bookings around the UK (excluding London) to European destinations when comparing Q1 2017 to Q1 2018. This figure increases to 128% for transatlantic flights to the United States, 147% increase in flights to Asia and an incredible 250% increase in flights to the Middle East. It's clear from the data that regional hubs around the UK are having more influence on international tourism and will continue to do so.

In Doncaster's case, to really be considered as an international hub, this takes a while. You can launch a regional route but as an airline, you don't want to be the only one playing on the playground. It really needs a combined effort between the airport and airlines to make this a success. For example, American Airlines launched JFK to BHX (Birmingham Airport) a couple of years ago and it lasted one season. It's going to take time, but gradually, we should see greater numbers of international long-haul flights from regional UK airports at a sustained level, which will help inbound and outbound tourism. ■

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A new Europass for better communication of skills and qualifications

Marianne Thyssen, European Commissioner for Employment, Social Affairs, Skills and Labour Mobility explains how a new Europass ensures better communication of skills and qualifications in Europe today

For over a decade Europass has made it easier for people to study or work across Europe, by making their skills and qualifications easily understood. Europass tools have served as a crucial bridge between the world of work and education and training. Millions of people have used it to communicate skills, experiences, qualification and credits, as well as languages, learned while on mobility, at work and volunteering. The Europass CV alone has been downloaded more than 100 million times since 2004.

Now the time has come for change and modernisation. When looking for jobs or new opportunities today, it goes without saying that how we communicate and what we communicate has changed dramatically. Europass was originally built around a limited portfolio of documents. The Europass CV – recognised all over Europe – is the most widely known template, but Europass also ensures, among other things, a common understanding of language skills and diplomas obtained. With the adoption of the new Europass Decision by the Council and Parliament in April 2018, we now have an exciting opportunity to modernise Europass and respond to the changing needs of learners and workers.

I proposed an ambitious and forward-looking service. The new Europass will offer an e-portfolio for people to manage their learning and careers – they can store and share information on work experience, education and references, create digital documents such as CVs and access tools to self-assess their skills. This will make it even easier for people to make their skills and qualifications more visible and for employers to assess a job applicant's knowledge and experience.

For the first time, Europass will offer information to support career management including information on skills trends and demands in the labour market and on guidance and learning opportunities across Europe. This will help people make informed choices about their career. On top, it will be a useful tool for policymakers looking to adapt training and employment policies based on labour market needs and trends. The new Europass will respond to the changing nature of the European labour market, embracing digital technology to connect individuals with employers, guidance services and education and training providers more easily.

"Now the time has come for change and modernisation. When looking for jobs or new opportunities today, it goes without saying that how we communicate and what we communicate has changed dramatically. Europass was originally built around a limited portfolio of documents. The Europass CV – recognised all over Europe – is the most widely known template, but Europass also ensures, among other things, a common understanding of language skills and diplomas obtained."

Europass remains a tool to support communication of skills and qualifications but importantly it also remains a free and open public service available to everyone. The Commission is working with Member States and stakeholders to ensure Europass is relevant and accessible to everyone and in particular the low-skilled, persons with disabilities or other disadvantaged groups.

The new Europass is one of the actions of our "Skills Agenda for Europe". Each of the 10 key actions seeks to make sure that Europe is ready to address fast-

Image: © European Union, 2018

Marianne Thyssen, European Commissioner for Employment, Social Affairs, Skills and Labour Mobility

changing skills needs and to seize the opportunities of the changing world of work. We have now rolled out all 10 actions of the Skills Agenda and we are starting to see the results on the ground.

"For the first time, Europass will offer information to support career management including information on skills trends and demands in the labour market and on guidance and learning opportunities across Europe. This will help people make informed choices about their career. On top, it will be a useful tool for policymakers looking to adapt training and employment policies based on labour market needs and trends."

At the core of the agenda is the simple fact that having the right skills is a route to empowerment and opportunity for all. A skilled, mobile workforce can enable social progress, growth and competitiveness. The vision for Europass and each of the Skills Agenda actions underpin our "European Pillar of Social Rights". The very first principle of the Pillar underlines the right to quality and inclusive education, training and life-long learning. The new Europass will actively support these rights by putting information and tools in the hands of Europeans to support their career management and communication of their skills. Work has begun on the implementation of the new Europass – the project will take forward the Pillar in a real and practical way, focus on user needs and put Europe firmly on a lifelong learning path. ■

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Equipping people with the skills that employers need

Keith Smith, Director, Apprenticeships Group, ESFA tells us why apprenticeships are at the heart of the UK government's ambition to equip people of all ages with the skills that employers need

Apprenticeships are at the heart of the UK government's drive to equip people of all ages with the skills that employers need. Apprenticeships play a key part in creating a stronger and fairer economy. Apprenticeships not only can help people of all ages and backgrounds fulfil their potential, in some cases up to degree level, but they help business address their skills shortages – from upskilling existing workers to attracting new diverse talent.

Thousands of employers already benefit from flexible and high-quality apprenticeship training to help their business grow. 86% of employers say that apprenticeships have helped them develop skills relevant to their organisation, with 78% reporting improved productivity.

For apprenticeships to offer such great opportunities for people of all ages, they must be of the highest quality. High-quality apprenticeships give apprentices confidence that the skills they are learning will help them to succeed, whilst employers will see the bottom line return of a workforce with the knowledge, skills and behaviours they need. Work continues to ensure that we create systems and experiences that apprenticeship employers and training providers require and that we do everything we can to create a high-quality experience, delivering the quality apprenticeships employers want. We continue to help the market work, through supporting the suppliers and providers of apprenticeships even more – but we monitor this; and will intervene heavily when quality fails.

Employer-led apprenticeship reforms are making apprenticeships even more valuable to employers by putting employers in control of the development of apprenticeships. Employers can choose the skills, training organisation, and how those apprenticeships are delivered – to ensure they meet their exact business needs.

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The apprenticeship system is developing and further changes to the apprenticeship funding policy, from August 2018, will explain how the government will fund apprenticeship training in England and will apply to all employers, both those paying the apprenticeship levy and those who do not. This includes changes to funding bands, simplifying rules to make planning and predictability easier, transitional support for providers training 16 to 18-year olds on the framework, additional payments for individuals and the transferring of apprenticeship service funds to another employer.

Many businesses already see apprenticeships as vital to their strategic plans to recruit for the skills that employers need, but there is of course lots more work to do to ensure that apprenticeships work for all employers. We are in constant conversation with employers across all sectors to ensure that their needs are being met, while helping them attract the right talent and boost the quality of candidates applying for their apprenticeships. Higher and Degree Apprenticeships, in particular, mean businesses can train more employees in high-level skills that are critical for business growth, whilst offering ambitious school leavers or experienced professionals looking to upskill, the opportunity to learn at university, to degree level.

Working with apprenticeship ambassadors – including the Young Apprenticeship Ambassador Network – and by working with schools – we are promoting apprenticeships through these connected and informed networks, spreading the word on how apprenticeships are making a difference to lives, business and the wider economy.

Since May 2015 there have been more than 1.2 million individuals starting an apprenticeship, which will provide each of them with the opportunity to gain the skills that employers need. This is a fantastic achievement but it's only the start as we want to make sure all employers have the skilled workforce they need. We are ensuring apprenticeships are as accessible as possible, encouraging take up from under-represented groups so that even more people can benefit from the increased wage and employment prospects that apprenticeships offer. ■

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Degree apprenticeships revolutionise leadership learning

Andy Bailey of Ashridge Executive Education explains the extent to which degree apprenticeships revolutionise leadership learning

Public sector managers have an unprecedented opportunity to take their leadership skills to an advanced level thanks to the launch of degree apprenticeship programmes at Ashridge Executive Education.

The introduction of the apprenticeship levy in 2017 has led to a shake-up in workplace learning across the board – but it has been a particular game-changer in the public sector.

Masters-level management qualifications, which in times of austerity have been out of the reach of most managers in government or health service roles, can now be funded through the levy and accessed via approved providers such as Ashridge. They provide an exciting opportunity for public sector organisations to raise the standard of management practice, accelerate the development of their people and build the resilience individuals need to work in a challenging environment.

An innovative qualification

Ashridge is leading the way in this revolution in workplace learning with the development of two Degree Apprenticeships, which focus on the skills and behaviours managers need to lead their people successfully through change and ambiguity.

The level 6 Degree Apprenticeship programme is designed to boost the skills and performance of junior and emerging managers, by equipping them with tools and knowledge that will make an immediate difference in the workplace. Delivered across a three-and-a-half-year time frame, it results in the award of a BA in Business and Management from triple-accredited business school Ashridge, as well as Chartered Manager status.

The level 7 Degree Apprenticeship is aimed at fast track, middle and established managers who want to accelerate their progression into strategic leadership roles. It covers a mix of subjects, ranging from strategy and innovation to risk management and digital transformation. The two-year programme also places strong emphasis throughout on personal impact, leadership and the development of collaborative relationships.

Participants will be able to draw on Ashridge's wealth of knowledge and experience, as well as its solid track record in delivering management education for the public sector. The programme culminates in the award of a Masters in Leadership and Management.

A pragmatic approach

Both programmes combine virtual classes with a series of face-to-face residentials in the beautiful surrounds of the historic Ashridge campus. The approach is highly pragmatic, with an emphasis on delivering learning that centres around real workplace issues. Each module requires participants to take part in webinars and online discussions and to provide a written assignment. The employer is an important stakeholder in the process, championing participants through their studies and supporting them in applying their new-found knowledge in their roles.

Benefits for the organisation

The grounded in reality approach has measurable benefits for the organisation, aside from its ability to recoup its levy contribution. Individuals draw on live workplace scenarios as part of their studies, helping them develop fresh perspectives on real-time challenges.

"As individuals progress through the programme, they get to know and understand their organisation even more deeply, explains Professor of Leadership Practice Roger Delves. "So, they are not only improving their performance, they are also exploring and examining their own organisation in a way they wouldn't previously have done."

The module on self-management, for example, helps participants improve effectiveness by making small but significant shifts in behaviour. "Current participants have been applying the principles of time management to their working practice and have seen immediate improvements not just in their own productivity, but also in

levels of engagement because they have had more time to spend with their teams," says Roger.

Both programmes culminate in a substantial, supervised project, which focuses on an area of organisational challenge chosen in conjunction with the employer. "The organisation ends up with a really solid piece of internal consultancy which will be of enormous value," says Roger.

Realising employee potential

The Degree Apprenticeship programmes are highly valued by employees for their career-enhancing potential and are also a great tool for organisations who want to retain and motivate their best people.

Academic Director Jane Stevens believes they provide employers with a particularly valuable opportunity to invest in 'baby boomer' staff, who thanks to demographic and pension legislation changes, are set to play an important role in the future workforce.

"People in their 40s and 50s are often very high performers but get overlooked when it comes to development because of outdated perceptions about their potential and aspirations," she says. "Many of these individuals haven't had the chance to do any training since their early career, so Degree Apprenticeships are a great opportunity to help them rejuvenate their thinking and refresh their skill set."

Jane, who herself has experience of combining high-level study (an MBA) with a full-on public-sector role (senior clinical leader in the NHS) says participants should expect to find the programmes challenging and will need to find ways of maintaining their work-life-study balance.

"It's about organisation, discipline and boundaries," she says. "You have to be very organised about how you use your time but also be firm with your employer – and possibly also your family – about when you are going to be studying, and to protect that time."

"People are telling us, however, that they are finding it very rewarding," she adds. "They are enjoying the study and in particular the instant application of learning to practice."

Looking ahead

The Degree Apprenticeships are currently offered as open programmes, which allow participants to learn with peers from a wide range of backgrounds and disciplines. This brings enormous benefits in terms of networking and the opportunity to generate fresh insights, based on the experience of others.

Ashridge is, however, also open to discussing closed cohorts for organisations with significant numbers of participants or who wish to form a consortium with other public-sector organisations.

Looking further ahead, there are also plans to supplement the levy-funded Degree Apprenticeship programme at level 7 with a premium product which leads to an Ashridge MBA.

"We have been at the forefront of innovation in management education for over 60 years and we are proud to be once more leading the way in this new and exciting field of Degree Apprenticeships," says Roger Delves.

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The Apprenticeship Levy UK government initiative

Ben Rowland from Arch Apprentices provides comment on the apprenticeships levy in the UK

The apprenticeship levy has brought many changes to the world of apprenticeships in the last year. Its introduction in April 2017 has caused a major shift in how apprenticeships are delivered and assessed – and even who an apprentice can be. Employers and training providers alike have had to quickly adapt to these changes – but at Arch Apprentices, we feel that this can only be positive.

What is the levy?

The Apprenticeship Levy is a UK government initiative introduced to encourage employers to hire apprentices, aiming towards their target of 3 million apprentices by 2020. Employers with an annual pay bill of more than £3 million, minus the offset £15,000 payable to HM Revenue & Customs (HMRC), are required to pay 0.5% into a levy pot. The funds in this pot are then transferred into vouchers only redeemable for the training of apprentices.

For employers with a pay bill of less than £3 million, they are required to pay 10% of the apprenticeship funding, with the government covering the remaining 90%. Where a 16-18-year old is hired, the government also offer grants to outweigh the cost of training.

What have been the impacts?

The levy has achieved its goal of bringing apprenticeships front of mind for most employers within England, as large companies debate the benefits and challenges of using their levy funds against the cost of losing them.

At Arch Apprentices, we have seen a huge demand from these employers asking for our support in developing apprenticeship schemes and internal processes to ensure that these funds are being used. Many are seeing this as an opportunity for improving their learning and development programmes and are encouraging a culture of lifelong learning within their organisation.

This has been proven to improve staff satisfaction and retention, with a report by Association of Accounting Technicians (AAT) finding that offering training and opportunities for personal development makes employees feel valued and more likely to stay much more than a promotion.

And this is not limited to young people. The introduction of the levy has also resulted in a relaxation of the strict rules around who can be an apprentice. Previously, funding was unavailable for apprentices over the age of 24 and only half available for those 19-24 years old meaning that the majority of apprentice were between 16-18.

Now, there are no funding restrictions applied, opening the doors for people of all ages to study an apprenticeship. This has meant that companies can put their existing staff onto an apprenticeship and convert current training programmes. As such, this has led to a rise in higher and degree level apprenticeships.

Further to this, the UK government have also brought in reforms to the apprenticeship programmes, scrapping the old frameworks and replacing them with standards. Standards are more rigorous than frameworks and include an endpoint assessment, which is a final assessment and evaluation of the apprentice's learning.

Arch Apprentices have welcomed the change to standards, as we feel that these are a major improvement in apprenticeship training and prepare young people for actual jobs. Ben Rowland, Co-founder of Arch Apprentices says: "Everyone at Arch is excited by and has embraced, standards – we genuinely believe they are a step better than frameworks."

This is because they are developed through employer trailblazer groups, who work together to create programmes that map to actual jobs and the needs of the employer. As such, apprenticeships are being developed to address the skills needs of the workplace.

Ben Rowland continues: "The Apprenticeship Levy has brought many challenges in its first year, but it also offers opportunities for businesses to prosper as a result. With the improvement of learning and development within a company and chance to plug a growing skills gap, the levy brings a chance to rejuvenate and advance the talent currently present in the English workforce." ■

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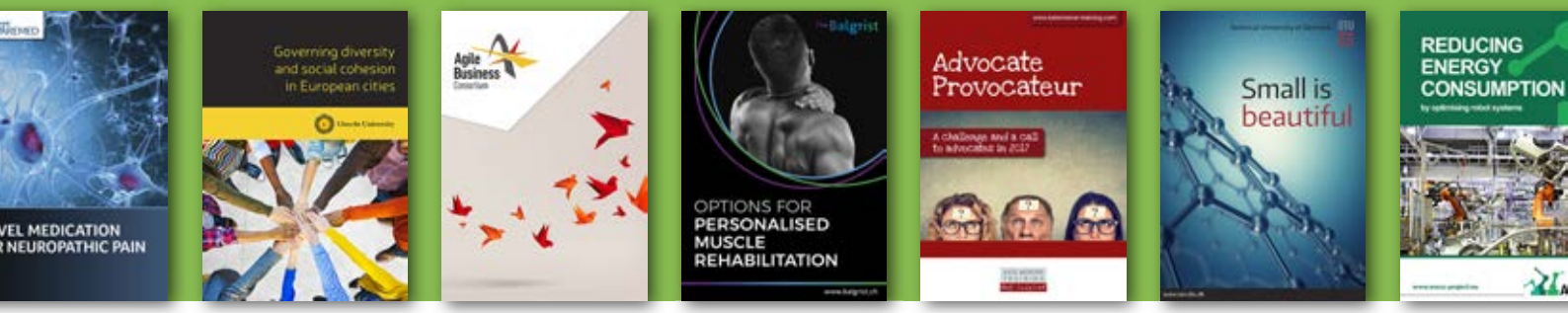

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