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## ASTRONOMY AND THE UNIVERSE OF DISCOVERY

RICHARD F. GREEN, DIRECTOR, DIVISION OF  
ASTRONOMICAL SCIENCES, U.S. NATIONAL  
SCIENCE FOUNDATION (NSF) EXPLORES THE  
WONDERS OF ASTRONOMY AND THE  
UNIVERSE OF DISCOVERY

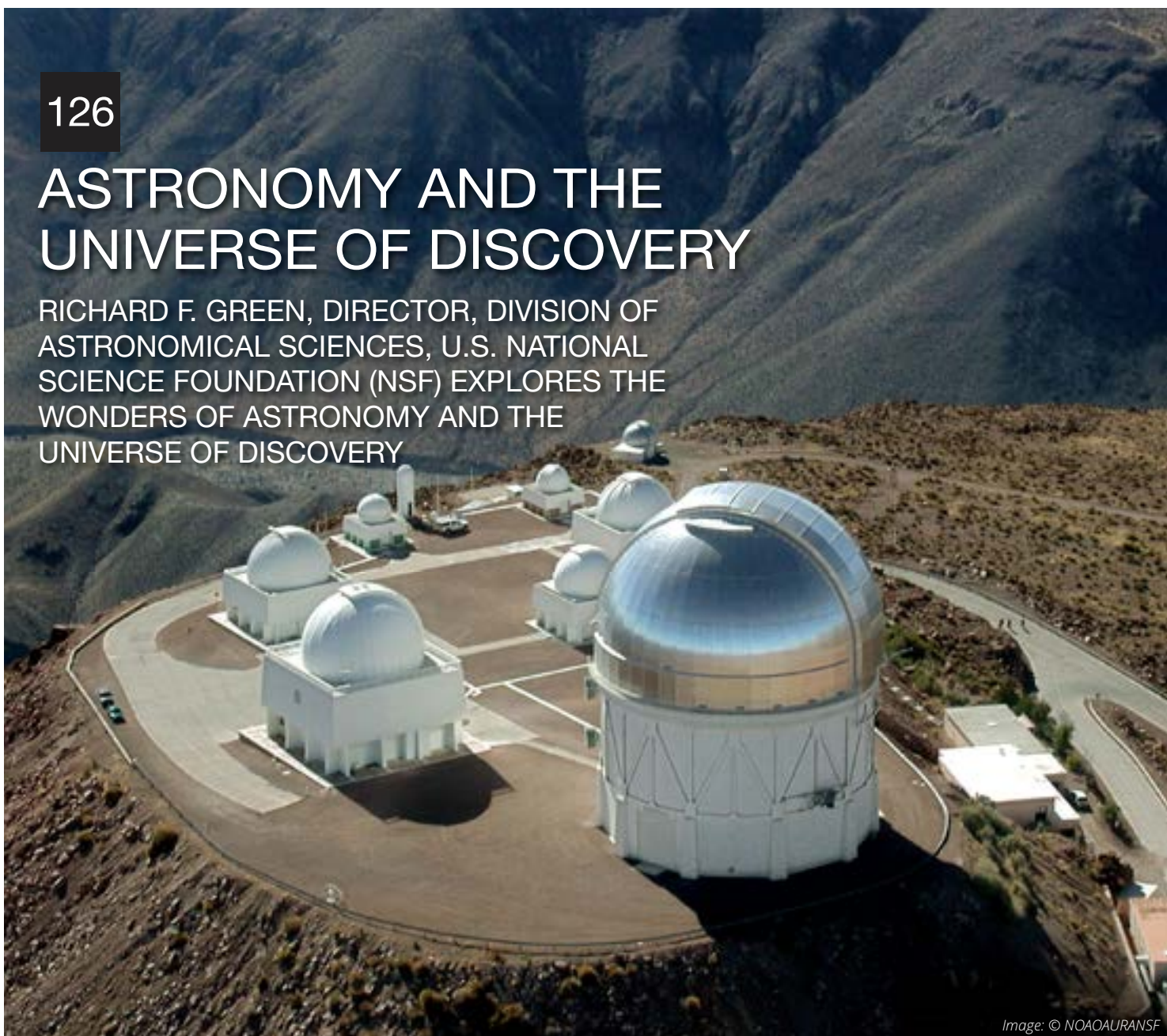


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**C**reativity, innovation and a strong focus on social and cultural aspects of sustainability are at the very heart of developing the Municipality of Varberg to become the Swedish West Coast's Creative Hot Spot by 2025.

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public transportation and a sustainable lifestyle. And it shows in the many awards we get.

### **Best place to live**

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

**Peter Schmidt**

**Member of the EESC Workers' Group (Group II)**

European Economic and Social Committee

**National Officer of European and International Affairs**

Nahrung-Genuss-Gaststätten (the Food, Beverages  
and Catering Union in Germany)

**N**ever before in the history of Europe have food safety and quality been as high as they are today. More food is being produced in Europe than ever before and it has never been easier to obtain: everything is available, anytime and anywhere.

So, does this mean we now have the perfect agri-food industry? Far from it! The industry's reputation is now worse than ever: the list of negatives includes species extinction and cruelty to animals, as well as food scandals, profiteering by multinationals, low prices for small farmers and poor working conditions in parts of the food industry. Moreover, European agricultural policy over the past 50 years or more has focused solely on maximising food production, with no regard for what is being produced and how.

## Food facts

- No other supply chain has as many unfair trading practices as the food sector.
- Food is being wasted more "cheaply" than ever before, as a direct result of this unhealthy competitive structure. These developments mean that the value of the food is lost.

- Current agricultural policy has not been able to guarantee an adequate income for farmers.
- There is no cohesion between the domains of sustainable agriculture, healthy eating, environmental protection, fair trade relations, etc. – and there absolutely needs to be, if we are to implement the UN's sustainability goals.

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**"Metaphorically speaking, a comprehensive food policy could be seen as a temple in which the foundations are formed of governance and coordination."**

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- It has been shown that many people have poor diets due to social inequalities and food poverty, with enormous long-term costs for their health. Some 37% of all deaths in the EU are attributable to unhealthy diets.
- The EU's rich cultural heritage is being threatened by the food industry's massive marketing budgets.

These problems are the result of the chaotic structure of Europe's food industry and of a lack of policy coordination.

Each market operator focuses on its own interests and the policies that ought to be bringing order to the chaos are a wholesale failure. The problem is that, unfortunately, far too many politicians in the Member States – and in Brussels too – are quite obsessed with the idea of neoliberalism, which blinds them to the overall picture, namely the need for a comprehensive pan-European food policy.

The European Economic and Social Committee recently adopted an opinion on this subject, setting out tangible first steps and recommendations.

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**“Never before in the history of Europe have food safety and quality been as high as they are today. More food is being produced in Europe than ever before and it has never been easier to obtain: everything is available, anytime and anywhere.”**

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So, what does a comprehensive food policy based on the sustainability goals need to achieve?

- It must be socially, environmentally and economically sustainable;
- It must be integrated across sectors and levels of governance;
- It must be inclusive of all sectors of society;
- It must ensure fair working conditions at all levels.

Metaphorically speaking, a comprehensive food policy could be seen as a temple in which the foundations are formed of governance and coordination.

The pillars of the temple then represent the following areas:

- Agriculture and thus CAP reform;
- Balanced territorial development/rural development (Cork 2.0);
- The transition to a circular economy;
- Sustainable consumption patterns;

- Fair distribution within the supply chain;
- Preserving Europe’s cultural diversity;
- Environmental protection;
- Education;
- Trade.

The roof of the temple represents food policy itself. In order to build this temple, the European Commission needs to take the initiative and take the following necessary steps:

- A cross-sectoral, inter-institutional task force should be set up, with the aim of developing an action plan on food sustainability.
- It is important to make use of the hearings organised by the European Economic and Social Committee when preparing the opinion.
- An “EU sustainable food scoreboard” should be developed to encourage and monitor progress towards the targets set.
- A new European Food Policy Council should be set up.
- The transition to sustainable European food systems requires the development of EU sustainable dietary guidelines, including guidance on smart labelling for sustainable food.
- The European Commission, the European Parliament and the Council are therefore requested to explore whether it would be useful to create a dedicated Directorate-General for Food, which could take the initiative on regulation, legislation and, potentially, enforcement.

If politicians want to take long-term, sustainable action, they need to develop a strategy that takes account of these proposals, which would be implemented in agreement with all the participants in the supply chain. This is not primarily about adopting new laws, but rather about coordinating and integrating the wide variety of initiatives that already exist. ■





**Jonathan Miles**  
Editor

**Production Coordinator**  
Nick Wilde

**Designers**  
Andrew Bosworth  
Ben Green

**Sales**  
Natalia Barbah  
Debbie Cotterill  
John Hoinville

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Electra Way  
Crewe Business Park  
Crewe  
Cheshire CW1 6ZF

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# INTRODUCTION

Welcome to the February 2018 edition of Open Access Government. This insightful document underlines a wide range of government policy issues from all around the world, including health, science and research, ICT, transport, environment, energy, the built environment and agriculture. We have an excellent mix of contributors, including government ministers, European commissioners, industry associations and charities.

One of the highlights of putting together this journal was interviewing Sweden's Minister for Policy Coordination and Energy, Ibrahim Baylan. He spoke to me about the importance of a sustainable Swedish energy policy and he reveals that The Government of Sweden has set a target for the country to become the first totally fossil free welfare society. In further inspiring content, the comprehensive health & social care section is headed up by Minister of Social Affairs and Health in Finland, Pirkko Mattila. In her article, she explains how she aims to reduce the burden of non-communicable diseases in Finland. Also in this section, Dr. Paul De Raeve, Secretary-General of the European Federation of Nurses Associations (EFN) details why the deployment of eHealth services in nursing and social care are key drivers for modern societies today.

Heading up the absorbing research and innovation section is Minister of Education and Research in Norway, Torbjørn Røe Isaksen, who sheds lights on his ambitions to increase the quality of higher education and research in the country. I'm also delighted that this section includes an article from Katherine Mathieson, Chief Executive of

the British Science Association. She explores what we can learn from the GM story when introducing new technologies into society.

A special focus on blockchain begins with an article by Vice-President and European Commissioner for Digital Single Market, Andrus Ansip, who shares his thoughts on how digitisation is changing both people and society, including disruptive technologies such as blockchain.

This packed edition is certainly full of this and many more profound insights, but one that really struck me came from the U.S. Department of Agriculture. Jaime Adams, senior advisor for international affairs argues that we need open data policies, especially in government to feed the world. She expands on this point further, by saying: "This global perspective will help identify existing data and data gaps and sharpen the focus on how open data can foster innovation and collaborative research, enabling comprehensive solution sets."

I hope that you find this wide-ranging edition both thought-provoking and useful. I would certainly welcome any comments you have on this February 2018 issue. Please also feel free to drop me a line about any suggestions for content you would like to provide in the future. ■

**Jonathan Miles**  
Editor



@Jonathan\_AdjDig

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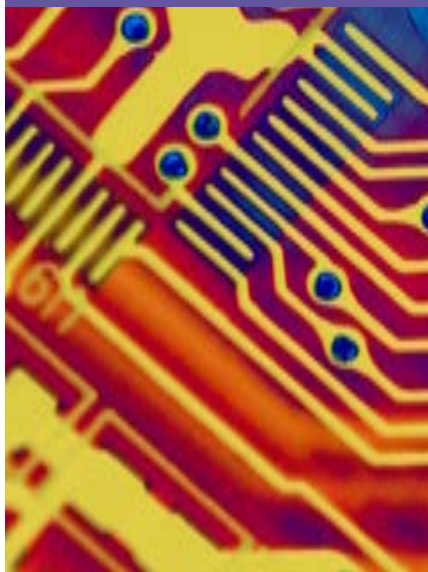
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# Reducing the burden of non-communicable diseases in Finland

Minister of Social Affairs and Health in Finland, Pirkko Mattila explains how she aims to reduce the burden of non-communicable diseases in Finland

Finland has a long successful history of health promotion and prevention of non-communicable diseases (NCD's). Activities to influence the NCD's were started in the early 70's when it was found out that Finnish men had the highest cardiovascular mortality in the world and lowest life expectancy in Europe. Data on risk factors revealed problems like the high level of smoking, poor dietary habits with low intake of fruits and vegetables, high intake of saturated fats and salt together with high cholesterol levels and high blood pressure. A good example of our successful work on nutrition and health is the so-called North Carelian Project. Regular monitoring of population health show success in reducing risk factors and improved health and wellbeing.

Public health has been seen as a responsibility of the government and a political priority. The key is to understand the inter-dependency of many different government policies and the need to influence the economic, social and environmental as well as commercial and political determinants of health. It is necessary to find partners through collaboration with other sectors.

In 2017, Finland celebrated its 100th anniversary with the slogan "Together". Our public authorities, the private sector and civil society all work together in providing social and health services. Non-profit organisations, as well as private sector companies, play an indispensable role in the wellbeing and health promotion at all levels.

We have been working together with health professionals to prevent and manage NCDs with a strong focus on health promotion and disease prevention. A consensus statement that focuses on prevention of NCDs was launched in spring 2017 by the Finnish Medical Association Duodecim and by the Academy of Finland. This statement emphasises, among other

things, the importance of the "Health in all policies" approach and supporting healthy lifestyles. Our focus from cure to prevention, prepared with more than 150 experts, pay particular attention to reducing inequalities from early childhood and improve recording, monitoring and evaluation of different health promotion tools.

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**"A major reform of social and health care services is in the process of being drafted in Finland. It aims to provide people with services on an equal basis than before, level out differences in health and wellbeing and curb cost increases."**

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Multi-sectoral policies on risk factors, such as unhealthy dietary habits have significantly contributed to a reduction of the NCD burden in Finland. These policies have included the reduction of salt and saturated fat, increased consumption of vegetables and fruits, combined with the promotion of other health-related habits. Schools provide health education, physical activity and free school meals with high nutritional values for our children. The agricultural sector promotes healthier foods and the ministry of finance carries excise duties on soft drinks, alcohol and tobacco. Our action plan – "Roadmap towards a Smoke-Free Finland" – aims to eliminate the use of tobacco products by the end of the year 2040.

Co-operation with NGO's and the private sector is an essential part of nutrition policy. For example, NGO's have developed a "better choice" heart symbol logo, to be used in food labelling by industry and catering services, indicating foods with better nutritional quality, meaning less salt, sugar, saturated and trans fats and more fibre. As part of the Agenda2030 implementation a new web-based tool, "Nutrition Commitment", was launched in June to help companies to highlight their activities related to food reformulation, increasing



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

intake of vegetables and fruits and self-regulation of portion sizes.

The Public Health Act was introduced in 1972 with the aim to shift emphasis from health care to preventive health care and outpatient care. The Occupational Health Care Act of 1978 was marked by a strong preventive orientation. In the 90's, permanent structures for cross-sectoral collaboration were established. In 2006, legislation with a multi-sectoral perspective and requirement to the promotion of health and wellbeing at the local level in the municipalities was adopted.

A major reform of social and health care services is in the process of being drafted in Finland. It aims to provide people with services on an equal basis than before, level out differences in health and wellbeing and curb cost increases. For the client, the service integration means fewer extra visits and shorter waiting times. Services for families with children, for example, will be combined into packages with a focus on multi-professional early support. Services for older persons and persons with disabilities will also undergo reform.

In the future, clients can choose either a public, private or third-sector service provider when they need a service that falls within the scope of freedom of choice. The aim is to create more robust services, especially at the basic level. Services will form effective care and service chains and there will be more electronic services and increased self-care is encouraged. All these actions will give us more possibilities and better tools to prevent and manage NCD's. ■

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

Finnish Government

Tel: +358 295 16001

[info@vnk.fi](mailto:info@vnk.fi)

<http://valtioneuvosto.fi/en/sipila/minister-of-social-affairs-and-health>

[www.twitter.com/MattilaPirkko](https://twitter.com/MattilaPirkko)



# Time for a change of tack on drug development for neurodegenerative diseases?

UCB's Duncan McHale outlines why reclassification might be a good idea to boost drug development for neurodegenerative diseases like Alzheimer's and Parkinson's

**N**eurodegenerative diseases are a growing global challenge, as medical advances ensure more individuals live longer. By 2020 there will be more than 40 million people in the world with Alzheimer's disease (AD) and by 2040, without the development of disease modifying drugs, this will rise to more than 80 million. Discovering and developing disease modifying drugs is proving very challenging, with many programmes failing. November 2016 saw another phase 3 failure with Lilly's solanezumab failing at the final stages of development. Is this the end of the amyloid hypothesis or a case of too little, too late and too broad?

been thought of as a disease of amyloidosis. Multiple potential therapies targeting amyloid processing have been developed and studied, with several still in the development stages. These therapies have all demonstrated an ability to reduce amyloid load in preclinical models, but this has so far not been beneficial to humans.

Amyloid is undoubtedly associated with AD and its presence has been a core part of the diagnosis, either post mortem or, more recently, through imaging techniques. However, the amount of amyloid does not correlate with disease severity and many subjects have significant amyloid deposits

but no symptoms. Despite these anomalies, the majority of current potential therapies have been targeting this mechanism. The community eagerly awaits the results of a clinical trial using Biogen's aducanumab as the most promising agent so far, but given the failure of other admittedly less potent molecules targeting amyloid deposition, many are pessimistic about a good result.

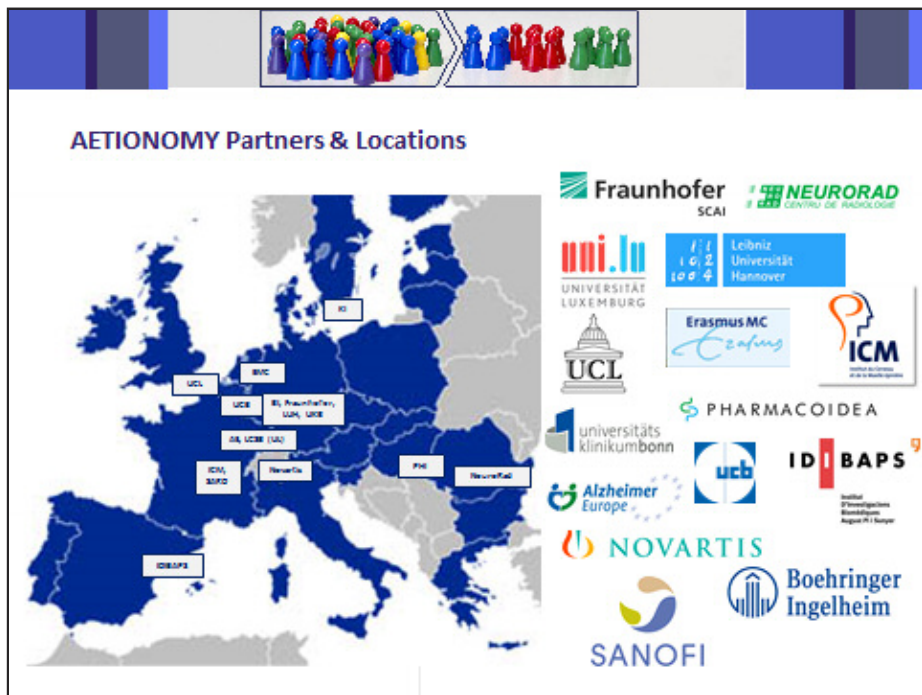
## Drug development for neurodegenerative diseases at a turning point

The failure of these therapies to date could be because the amyloid hypothesis is flawed and, despite the

**“AETIONOMY is an Innovative Medicine Initiative (IMI) funded consortium established to develop a mechanistic based classification of neurodegenerative diseases, with an initial focus on Alzheimer’s and Parkinson’s disease.”**

## The amyloid hypothesis

Alzheimer's disease is a chronic neurodegenerative disease which usually presents in the seventh or eighth decade of life. However, earlier onset is not uncommon. The cause(s) of AD are not fully understood but the presence of amyloid (protein) plaques in the brain was demonstrated in 1911 and since this time the disease has



association, amyloid is a downstream consequence of the disease process and not pathogenic in its own right. However, the presence of familial forms of the disease caused by genes involved in amyloid processing make this unlikely. For example, the presenilin 1 gene is part of a protein complex which degrades amyloid, creating the pathological 42 amino acid peptide.

**“By 2020 there will be more than 40 million people in the world with Alzheimer’s disease (AD) and by 2040, without the development of disease modifying drugs, this will rise to more than 80 million.”**

It is much more likely that, for most individuals, amyloid is not the sole cause and additional pathological mechanisms are involved. Indeed we now know that the Tau protein is one of these additional mechanisms. It is therefore time to start focussing on some of these other mechanisms to find the causes of AD, which we can then target with new therapies. We need to look for mechanisms that are important in later stages of the disease process and/or can still be successfully modified once the very early symptoms appear. AETIONOMY is a consortium with the sole purpose of identifying these other mechanisms involved in AD and reclassifying neurodegenerative disease using these discriminatory mechanisms, which will help us develop new treatments.

At AETIONOMY we have been taking the totality of research in AD and, using our knowledge base, integrating this information into a common framework to search for other potential mechanisms. By looking for these other mechanisms we hope to find sub-populations of patients who can be treated by targeting the cause in



them which is present with the amyloid plaques. Success will result in a new way to classify AD beyond just the presence of memory problems and plaques. Success will also result in new mechanisms for targeting and precision medicines for AD.

## AETIONOMY

AETIONOMY is an Innovative Medicine Initiative (IMI) funded consortium established to develop a mechanistic based classification of neurodegenerative diseases, with an initial focus on Alzheimer’s and Parkinson’s disease. This public private partnership is co-led by myself and Martin Hofman-Apitius from SCAI Fraunhofer. The premise behind the project is that, although large sums have been invested in research in neurodegeneration and a lot of data generated, the co-ordination and integration of this data across the community has been less well addressed. The consortium has brought together experts in

informatics, computing, engineering, mathematical modelling of disease, neuroscience and clinical neurology from leading academic centres, as well as neuroscience, informatics and neurology drug development experts from the EFPIA Industry partners.

**AETIO** **N/O**  
**M/Y**

**Duncan McHale**  
**Head of Global Exploratory Development**  
UCB  
Duncan.McHale@ucb.com



# Could the new public health professional please stand up?

EUPHA Executive Director, Dineke Zeegers Paget explores the importance of improving public health in Europe

**T**he European Public Health Association – EUPHA – is an umbrella organisation for national public health associations, active in 45 European countries. EUPHA's vision is of improving health and well-being and narrowing health inequalities for all Europeans. We seek to support our members to improve health in Europe, adding value to the efforts of stakeholders in regions and states, in national and international organisations, as well as individual health professionals.

For the EUPHA strategy 2014-2020, we have three main objectives:

- To be a leading scientific and independent voice in the field of public health and health services research and policy;
- To build capacity and knowledge in the field of public health and health services research with the aim of supporting evidence-informed practice and policy decisions and;

- To prepare future generations of engaged and connected public health professionals for their leadership role in public health.

EUPHA uses a wide definition of public health professionals: 'all professionals that monitor and diagnose the health concerns of entire communities and promote healthy practices and behaviours to ensure that populations stay healthy. This definition specifically includes health services researchers'.

This definition and the EUPHA strategy 2014-2020 expect from a public health professional that he/she can as easily talk to a politician and concerned citizen, as well as interact with researchers. And a public health professional who can present research in a timely and concise manner, preferably in a way that politicians get their questions answered even without asking them. In the EUPHA strategy, we are asking the new public health professional to stand up. So how can we create/nurture this new public health professional?





*Dineke Zeegers Paget LLM PhD, Executive Director*

If we – the public health professionals – want to have a leading and independent voice in public health, we must adapt to the new and fast society. We can no longer do our research in the old-fashioned way, but we must use a different approach with ongoing interaction with the policymakers and flexibility to adapt the main question or add sub-questions to be answered in the research. Being a leading voice also requires being able to react quickly and concisely to new questions, being a health diplomat, advocate and knowledge broker all in one.

This new role of public health professionals requires an expansion of the training and capacity building of public health professionals. At the European Public Health conferences, initiated by EUPHA, the number of skills building workshops is increasing every year. Skills building nowadays goes beyond 'how to write a scientific article' and includes advocacy, public health storytelling, consumer involvement, etc. And this wider view of the role of public health professionals is already taken up in schools of public health as well.

It is important that the new public health professional becomes part of the existing public health networks, so knowledge is transferred, and continuity is ensured. This is why EUPHA is investing in the future generation of public health professionals, for instance by the creation of the EUPHANxt network (for the next generation of public health professionals). Including students and young professionals in all levels of your organisation will not only allow you to teach the young, but also to learn from the young on innovative ways of communicating, presenting evidence and combining research with policy setting.

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**“This new role of public health professionals requires an expansion of the training and capacity building of public health professionals. At the European Public Health conferences, initiated by EUPHA, the number of skills building workshops is increasing every year.”**

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In March 2017, the White paper for the future of the European Union was published. In this paper, the 4th future scenario specifically mentioned public health as one of the areas where the European Union has a lesser role to play. This is frightening, as public health is part of the whole of society and a healthy population enhances a healthy economy.

It is therefore essential that the new public health professional – the one who can talk to politicians, citizens and colleagues, summarises the newest evidence in one tweet, the one who can stimulate all areas of society to take public health into account and clearly say that public health is a European matter – stands up and continues the work of the whole public health community. And EUPHA is there to support the public health community anyway we can. ■

**Dineke Zeegers Paget LLM PhD  
Executive Director**

European Public Health Association (EUPHA)

Tel: +31 30 2729 709

[d.zeegers@euphaoffice.org](mailto:d.zeegers@euphaoffice.org)

<https://eupha.org/>

<https://twitter.com/EUPHActs>

# IDEAS: improving design, evaluation and analysis of early drug development studies

Prof Thomas Jaki from the Medical and Pharmaceutical Statistics Research Unit at Lancaster University explores a novel approach to Ph.D. training for those in the pharmaceutical industry

The pharmaceutical industry is one of the main employers of statisticians hiring across all levels of education. According to Morgan (1999)<sup>1</sup> in Switzerland, 40% of statisticians in the pharmaceutical industry do have a Ph.D. Despite this high demand for highly trained statisticians in the pharmaceutical industry, most existing Ph.D. programmes focus on pursuing a narrow research question and do not offer additional training relevant to someone working as a pharmaceutical statistician.

**“Unlike the traditional model where the student is supervised by a single academic supervisor, students in IDEAS are supervised by at 2 experienced researchers, one working in academia while the other works in the industry.”**

To provide tailored Ph.D. level training for someone aspiring to work as a statistician in (early) drug development, we have set up the IDEAS (Improving Design, Evaluation and Analysis of early drug development Studies) network ([www.ideas-itn.eu](http://www.ideas-itn.eu)). It consists of 8 partners (3 industrial and 5 academics) from 7 European countries that work together to provide a unique Ph.D. programme. Together with several associated partners (largely from industry) it offers a programme that consists of:

1. Individually supervised research projects;



2. Transnational, cross-sectorial secondments;

3. Network-wide training activities and;

4. Individual training activities.

The individually supervised research projects form the core of the research undertaken by a student and focus on statistical challenges relevant to early drug development. Unlike the traditional model where the student is supervised by a single academic supervisor, students in IDEAS are supervised by at 2 experienced researchers, one working in academia while the other works in the industry. To complement the supervision a clinical advisor is

associated with every project to ensure the practical utility of the work.

The transnational, cross-sectorial secondments are visits of the students to partner organizations of 3-12 months. The principle of these secondments is that students based at an industry partner spend the secondment with an academic partner and similarly students at an academic institution have their secondments at an industry partner. This allows students to experience both the academic as well as industry environment during their studies.

Besides the secondments, the second main place where students gain



The MPS Research Unit is pleased to announce our programme of short courses for 2017/2018 on advanced concepts in the design and analysis of clinical trials. Our courses are aimed at statisticians working in clinical research. Courses take place in the attractive accommodation of the Postgraduate Statistics Centre at Lancaster University. Presenters will be Thomas Jaki, Andrew Titman and Fang Wan.

## CALENDAR FOR 2018

12 Feb – 15 Feb 2018	Pharmacological Modelling
26 Feb – 1 Mar 2018	Survival and Event History Analysis
12 Mar – 15 Mar 2018	Adaptive Methods in Clinical Research
4 June – 5 June 2018	Designing Early Phase Trials

For details of these and other courses offered by the Postgraduate Statistics Centre, go to <http://www.lancaster.ac.uk/maths/postgraduate/short-courses/> or contact Angela Mercer, Postgraduate Statistics Centre, Department of Mathematics and Statistics, Fylde College, Lancaster University, Lancaster LA1 4YF, UK.

Tel: +44 1524 593064 email: [a.j.mercer@lancaster.ac.uk](mailto:a.j.mercer@lancaster.ac.uk)

All of these professional development courses, as well as many other, 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 to discuss your specific requirements or for further information.

specialised knowledge relevant for drug development are the network-wide training activities. During their studies, students participate in 4 week-long training events and one think-tank. During these events students give updates on their project to receive critical feedback from the wider network, undertake specialist training relevant for drug development (e.g. dose-finding, regulation) and training in transferable skills (e.g. developing entrepreneurial skills, project management).

The final component of the programme is individual training. This training is used to develop the student further based on the specific needs of the individual. The exact training programme is developed with the supervisory team and forms the basis of a personal career development plan. The

individual training activities range from career planning sessions via specialist courses to conference attendance.

## Acknowledgement

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No 633567 and by the Swiss State Secretariat for Education, Research and Innovation (SERI) under contract number 999754557. The opinions expressed and arguments employed herein do not necessarily reflect the official views of the Swiss government.

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**Prof Thomas Jaki**  
**Professor of Statistics**  
 Medical and Pharmaceutical Statistics  
 Research Unit  
 Lancaster University  
 Tel: +44 (0)1524 59 23 18  
[mps@lancaster.ac.uk](mailto:mps@lancaster.ac.uk)  
[www.ideas-itn.eu](http://www.ideas-itn.eu)

# Three million EU nurses leading digitalisation

Dr. Paul De Raeve, Secretary General of the European Federation of Nurses Associations (EFN) explains why the deployment of eHealth services in nursing and social care are key drivers for modern societies today

The deployment of eHealth services in nursing and social care are key drivers for modern societies. However, the current 'unmet needs' of different stakeholders create a barrier for successful and deployable digitalisation. In societies where a growing number of people live with co-morbidities, non-communicable diseases, and complex care pathways, the people-centred policy approach can only function when tailored to the end-user and frontline service provider needs.

As such, co-design of policies and technology should become the rule, not the exception. This implies that companies' business models will need to adapt to these unmet stakeholder needs before they jump into the rhetoric of 'measuring outcomes', desperately holding on to 'disease-oriented value-based health systems'. In contrast, people-centred care implies the care model being organised around the health and social needs of end-users, rather than diseases.

Integrating primary and secondary care on one hand, and health and social services, on the other hand, is based on a people-centred model of care that implies both frontline innovation and implementation research. Both can be complementary. Therefore, when designing future EU health and social care ecosystems, supported by frontline e-health services, it is crucial that digitalisation, including Robotics and Artificial Intelligence, supports hands-on care and coordination of care to reduce the unmet needs.

Technology cannot result in pulling nurses away from the bedside, instead, direct patient care needs to be urgently increased and technology, real innovation must support nurses doing so. The industry business model needs to incorporate the frontline workload challenge, to increase both quality and safety.

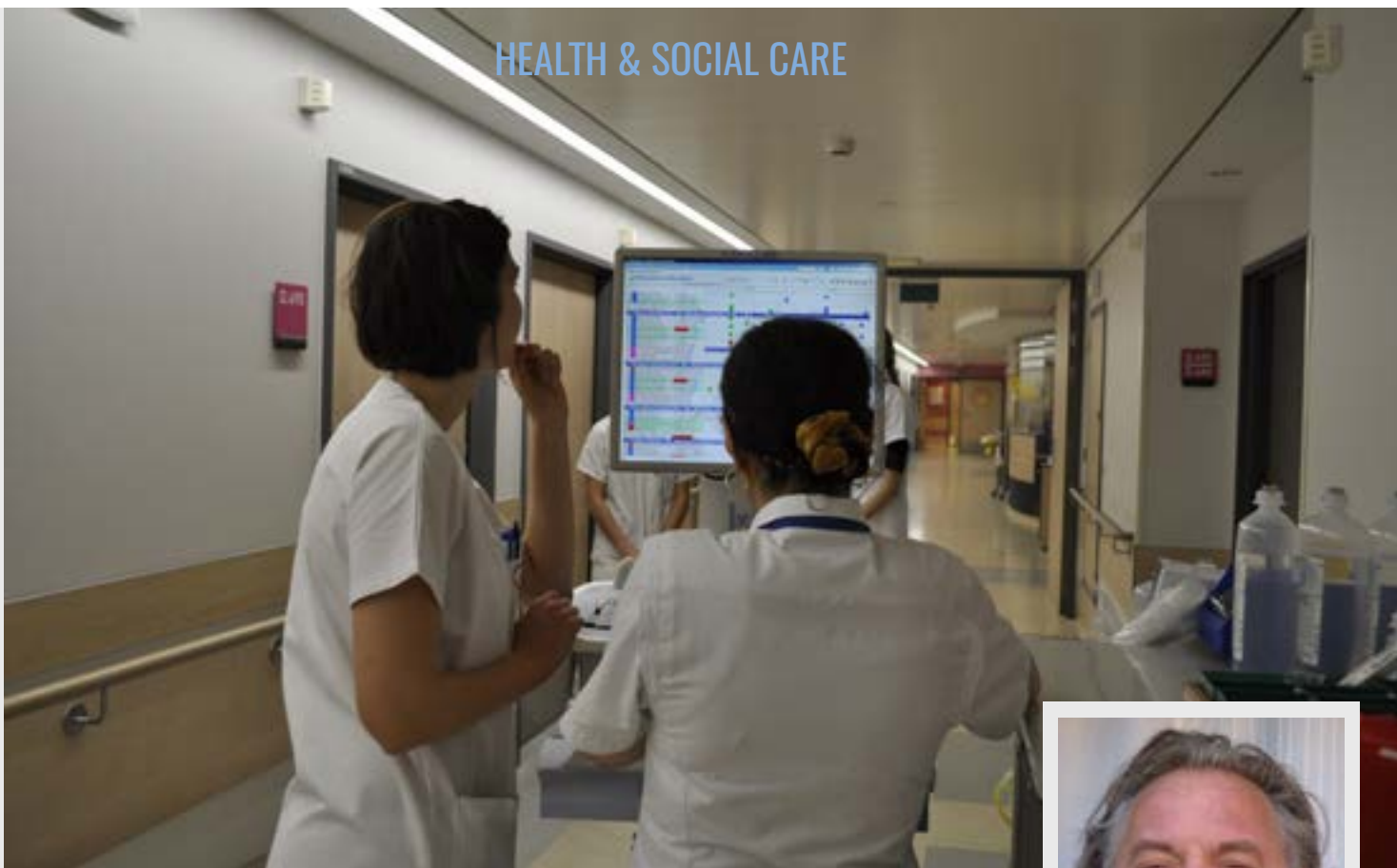
If meetings, projects keep on delivering documents, brochures, lancet articles, and not implementing findings, not just pilot projects, nothing will change. We see often millions spend on projects, but nothing implemented. So, industry develops a lot, but not with the end user.

Making nursing more central to health policy and technology design and ensuring that nurses can use their skills, including e-skills, to their full capacity, can lead to improved health and well-being, enabling the achievement of Universal Health Coverage. Supporting digital skills of the nursing workforce is even more needed in the context of the constantly changing nature of healthcare systems and healthcare delivery. The [EFN eSkills and Health workforce report](#) indicates the gaps in eSkills, while providing for a series of practical steps to be taken to make digitalisation happen. The health professional organisations, together with the patients' organisations, and the industry (SMEs) should consider eSkills development for the health workforce to address the increasing unmet needs, which then contributes to the implementation of the EU eHealth Action Plan 2012-2020.

Furthermore, supporting the empowerment of women in innovation and research, making business models more gender sensitive, will automatically lead to well-being, productivity and growth. Engaging nurses in policy and technology designs will have the triple impact of contributing to three of the Sustainable Development Goals – improving health, promoting gender equality, and strengthening economies (APPGGlobHealth, 2017).

To this regard, the EFN has produced EU guidelines on [eHealth services in Nursing and Social care](#), which mainly focus on prevention, clinical practice, advanced roles, integrated care and nurse-prescribing. ENS4Care





has provided an overview of the range/type of eHealth services currently being used for prevention, to extract knowledge on the use of eHealth applications as tools to enhance healthy lifestyles that will boost prevention in healthcare from a life circle approach, with gender being a key element in the equation to harness and gain maximum benefit from eHealth technologies.

The EU has ambitious plans to digitalise the market. Therefore, to be successful, it is crucial that the EU institutions, and the EU Commission, value and recognise the contribution of frontline nurses who daily are working to give of their best to people/citizens/patients in the most challenging environments. As such, the European Commission, DG Connect, should play a crucial role in steering digitalisation – to make sure that the unmet needs of end-users stay on the political agenda and funds are directed towards addressing these unmet needs – making digitalisation more ‘fit for purpose’.

In EFN's opinion, concrete EU actions to close down the implementation gap is urgently needed, not by putting Civil Society, NGOs, professionals, into the cloud, but working out concrete and focused actions frontline. Advancing an intersectoral policy agenda across the finance, labour, education, health and social sectors, should benefit end-users and SMEs. Large-scale investments in ‘fit for purpose’ eHealth solutions will become a precondition for growth.

*Dr. Paul De Raeve,  
Secretary General of the  
European Federation of  
Nurses Associations*



Moving digital care to the community fosters the added-value of health and social wellbeing as drivers in combating inequalities. A genuine commitment to reducing health inequalities means that brave decisions about what to start funding and possibly what to stop funding need to be made, hopefully within FP9. As such we can move from theories to deployment; from political speeches to frontline implementation; from recommendations to concrete actions for change. The end-users will need to lead this digitalisation. ■

De Raeve P., Gomez S., Hughes P., Lyngholm T., Sipilä M., Kilanska D., Hussey P. & Xyrichis A. (2016) Enhancing the provision of health and social care in Europe through eHealth. *International Nursing Review*. Online: <http://onlinelibrary.wiley.com/doi/10.1111/inr.12266/abstract>

**Dr. Paul De Raeve, RN, MSc, MStat, PhD  
Secretary General**

European Federation of Nurses Associations (EFN)

Tel: +32 2 512 74 19

[efn@efn.be](mailto:efn@efn.be)

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

[www.twitter.com/EFNBrussels](https://twitter.com/EFNBrussels)

# Therapies for weak muscles

Research into personalised interventions is helping pave the way for a new generation of therapies for weak muscles at the Balgrist Campus

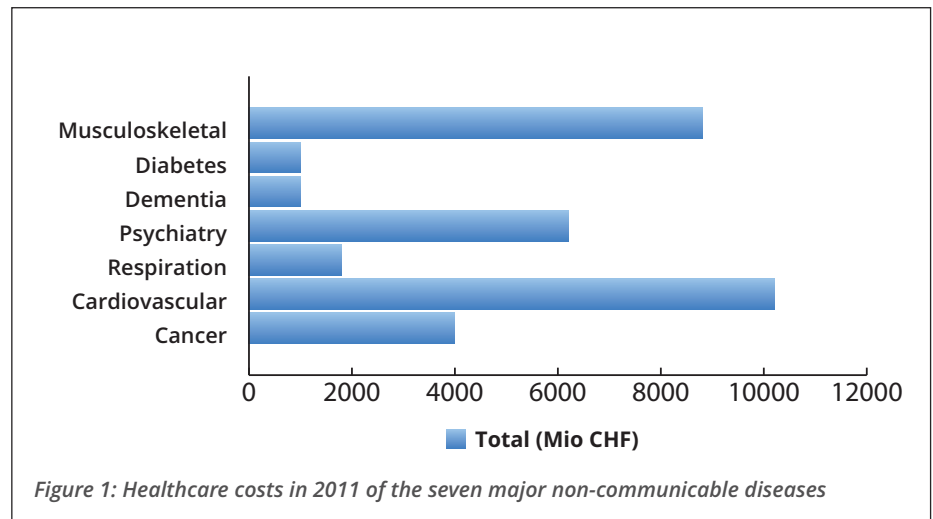
It is estimated that 10% of the cost of healthcare in Switzerland (or the equivalent of €500 billion per annum in the EU) being associated with lost work is related to injury or dysfunction of the musculoskeletal system (Fig. 1). Surgical and subsequent rehabilitative interventions are important part of the therapy that re-establishes musculoskeletal function.

The Laboratory for Muscle Plasticity at Balgrist University Hospital aims to shed light on the underlying mechanisms in skeletal muscle with the goal of translating the findings into more effective clinical applications.

Skeletal muscle plays a major part in control of movement and posture and affects whole body metabolism through its effects on energy expenditure. Affections ranging from simple overuse injury to rupture of tendons and bones, or disease, lead to deconditioning of skeletal muscle as a result of inactivity and damage signals. The consequent loss in muscle strength and fatigue resistance exerts a distinct negative impact on the quality of life and may render the affected individual dependent. In these situations a surgical intervention and rehabilitation may be indicated, yet may come too late as irreversible changes may have resulted.

## Focus on muscle plasticity

The Laboratory for Muscle Plasticity investigates the mechanisms that



underlie the conditioning of skeletal muscle structure and function during recovery from surgical interventions and rehabilitation. As shown through research on sport performance, this process is driven by mechanical and metabolic stimuli. It is mediated through a gene response that instructs adjustments in muscle composition with the repeated impact of exercise during training. In consequence, force production and fatigue resistance of muscle may be improved or maintained.

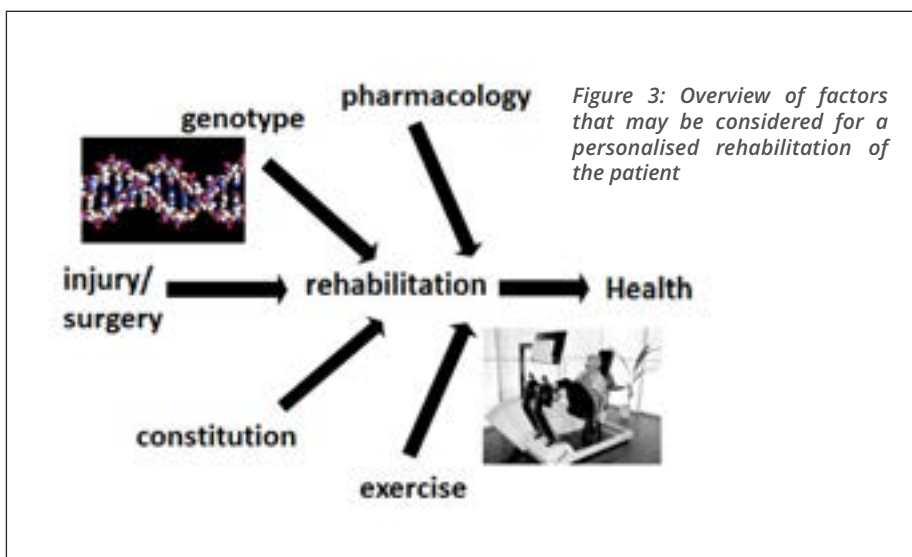
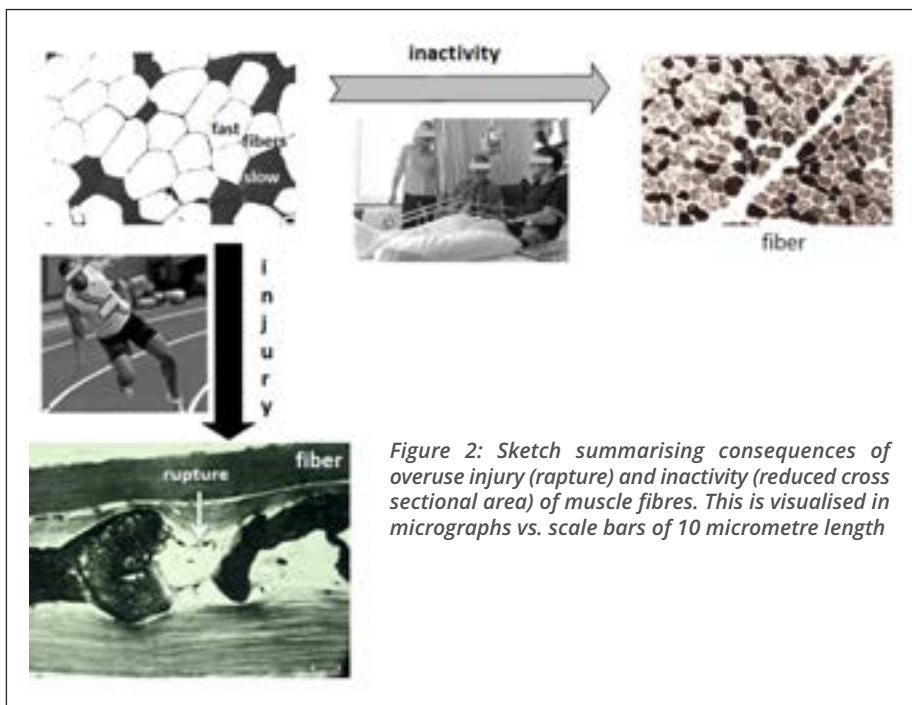
By contrast, a muscle's functional capacity is reduced in the absence of a physiological stimulus by a reduction in the size of muscle fibres and their content in mitochondria (Fig. 2).

In fact, while the safety and effectiveness of physical factors for muscle conditioning are well established, the dose-effect relationship between

exercise and muscle adaptation is often not fully respected in clinical practice. An example of this biological regulation is the important role of muscle contraction and loading in preserving muscle mass of the bedridden musculoskeletal patient after surgery, who would otherwise lose muscle mass at a pronounced rate. Genetic factors (so called gene polymorphisms) significantly affect this adaptation. This indicates that gene polymorphisms contribute to the inter-individual variability of the response to surgical interventions and rehabilitation.

## Research projects

The emphasis of the research team lead by Prof Martin Flück at Balgrist is on major musculoskeletal affections that arise in the context of the orthopaedic clinics at Balgrist Hospital. A special focus is put on resolving the contribution of gene polymorphisms



to inter-individual differences in the healing of muscle with re-attachment of the ruptured rotator cuff tendon, and the strengthening of skeletal muscle with rehabilitative exercise in patients.

The aim is to develop personalised forms of intervention that maximise muscle adaptation (Fig. 3). The latter approach is based on previous investigations pointing out the important exercise-intensity and exercise-type related influence of gene polymor-

phisms on muscle response to leisure-type sports activities. This opens a venue to tailor the therapeutically effective exercise intervention for patients which otherwise would demonstrate little plasticity to a generic exercise stimulus and for which pharmaceuticals alone do not work due to the importance of activity-induced muscle metabolism for muscle adaptations. In this regard, the clinical investigation ACE-REHAB into personalised rehabilitation of cardiac patients has been initiated.

### Patient-led research

The laboratory is situated in state-of-the-art research facilities at the Balgrist Campus. A key ingredient of this research facility is an open-space landscape where research and development into musculoskeletal medicine is integrated under one roof between clinicians, biologist, engineers, and industry. The facility situates in the vicinity of the orthopaedic hospital at Balgrist; thus providing a pipeline for a reality-driven approach that re-integrates questions from bedside to bench and returns to the patient. The Laboratory for Muscle Plasticity is looking for potential partners that may want to exploit the research options presented in the future campus in the frame of collaboration.



The **Balgrist**

### Professor Dr Martin Fluck

Laboratory for Muscle Plasticity

Balgrist Campus AG

Tel: +41 44 510 7350

[martin.flueck@balgrist.ch](mailto:martin.flueck@balgrist.ch)

<http://balgrist.ch/en/Home/Research-and-Education/Orthopaedics/Muscle-plasticity.aspx>



# A modern, accessible and equitable health care system

Open Access Government sheds light on the priorities of Sweden's Minister for Social Security, Annika Strandhäll to promote a modern, accessible and equitable health care system

Sweden's Ministry of Health and Social Affairs is responsible for all issues that fall under the concern of the welfare of society. This predominantly consists of promoting people's health and targeting the treatment of sick people, indeed the Ministry is constantly striving to ensure that everyone receives the treatment they need. The Ministry also provides insurance to allow a certain amount of financial security for those who are sick, elderly or have young children.

*“One aspect that the government is pushing to raise awareness in is the subject of mental health. Minister Strandhäll, spoke about effective strategies for better mental health at WHO Mental Gap Action Programme (mhGAP) forum on 10th October. The government sees a major need to expand investments in mental health services and as such, it is strengthening efforts in this area by providing SEK 650 million in 2018 and SEK 1150 million per year during the years 2019 and 2020.”*

Also included in the very broad sector of health and social affairs, is the high priority of providing care for people with social difficulties; the disabled and the elderly. The Ministry's work also includes promoting sports issues, rights of children and for those with disabilities, as well as gender equality. The Ministry takes both a modern and intersectional approach to its healthcare priorities and this approach is driven by Minister Strandhäll, who fronts and monitors the Ministry. She has been the Minister for Health and Social Affairs since 2017 and was previously Minister for Social Security between 2014 to 2017.

“As a minister in Sweden's first feminist government, the differences in the conditions for men and women are a natural starting point in my reform efforts,” states Minister Strandhäll. A modern, accessible and equitable

health care system is vital and with Sweden's overall governmental push for gender equality, (Sweden topped the EU Gender Equality Index in 2017), so this will continue to develop. Most recently, in the Budget Bill for 2018, the government presented a range of proposals to increase both security and welfare in Sweden, some of which are centered around ‘Gender equality and integration of newly arrived immigrants’.

The government is also currently implementing a record-breaking initiative on women's health – to strengthen skills supplied in maternity care and provide extra resources to initiatives for women's health in primary care – particularly in socio-economically disadvantaged regions. Furthermore, in February 2017, a project – ‘Gender-equal pensions’ – was carried out which aimed to tackle the challenge presented by the large differences in both women and men's pensions.

Strandhäll also stated that as Minister, she feels that it is vital that: “people with secure social insurance and pensions are able to make their own decisions in life. Sickness insurance should strike a balance between protection and demands, and pensions should be fair and enough to live on.”

This requires strategic, long-term and purposeful work. The government invests billions of krona annually in better and more equitable health care, both through targeted measures and through providing increased general government grants to county councils.

One aspect that the government is pushing to raise awareness in is the subject of mental health. Minister Strandhäll, spoke about effective strategies for better mental health at WHO Mental Gap Action Programme (mhGAP) forum on 10th October. The government sees a major need to expand investments in mental health

Image: © Photo Kristian Pohl



**Annika Strandhäll**

this area as a vital step towards a more modern, accessible and equitable health care system and is, therefore, giving SEK 64 million annually to support the sports movement's work with new arrivals in Sweden.

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**“As a minister in Sweden’s first feminist government, the differences in the conditions for men and women are a natural starting point in my reform efforts,” states Minister Strandhäll. A modern, accessible and equitable health care system is vital and with Sweden’s overall governmental push for gender equality, (Sweden topped the EU Gender Equality Index in 2017), so this will continue to develop.”**

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Overall, health care consists of the measures taken to provide care for those who are ill and the development of healthcare services. Care should be equitable, gender-equal and accessible and offered on equal terms, according to individual need. Needs-adapted health and medical care mean that care is given based on the needs of the individual patient. Sweden is striving to maintain and improve its already world-class health-care system. While it is true that life expectancy is increasing, along with the number of cancer survivors, there are still many hurdles to overcome so that this can be achieved. ■

services and as such, it is strengthening efforts in this area by providing SEK 650 million in 2018 and SEK 1150 million per year during the years 2019 and 2020.

However, public health in Sweden is about preventing all types of ill health, mental or physical. The Ministry covers everything from measures to promote public health and specific issues, such as protection against communicable diseases, alcohol and tobacco. The area of sport includes both public health issues, such as getting people to be physically active, as well as democratic perspectives, such as getting people to engage and assume responsibility for non-profit activities.

The area also includes initiatives to bring the experience of sporting events to the public, encouraging integration and accessibility, as well as promoting physical fitness. The government recognises the importance of

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[editorial@adjacentopenaccess.org](mailto:editorial@adjacentopenaccess.org)  
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# TGF- $\beta$ signalling – Tumor biology in prostate cancer

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

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

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

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

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

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

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

## **Collaboration**

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

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



**Professor Maréne Landström**  
Umeå University  
[marene.landstrom@umu.se](mailto:marene.landstrom@umu.se)  
[marene.landstrom@medbio.umu.se](mailto:marene.landstrom@medbio.umu.se)  
[www.medbio.umu.se](http://www.medbio.umu.se)





“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.”

# Sensory processing disorder in children

Cecilia Van Cauwenberghe from Frost & Sullivan's TechVision Group provides a comprehensive overview of sensory processing disorder (SPD) in children today

Children with sensory processing disorder or dysfunction (SPD) are characterised by the occurrence of inward information in very atypical, diverting modes.

## Energising diagnosis and treatment through multi-sensory behaviour and brain activity assessment

According to the American Occupational Therapy Association, the 5% of all children suffer from SPD, evidencing overstated aversive, isolation, or exhibiting behaviours associated with sensory inputs. Such a sensory processing differences experienced during childhood may lead to remarkable and permanent outcomes for learning and social abilities. These symptoms are usually common factors among children who are diagnosed with autism spectrum disorder (ASD) and attention-deficit/hyperactivity disorder (ADHD).

Nevertheless, even though some symptoms overlap between ADHD and SPD, children with SPD are often not well treated, receiving services only focused on similar behavioural impairments. This fact demonstrates the lack of quantitative assessments that would help to determine SPD specific needs to then provide a most beneficial type of intervention beyond qualitative behaviour-based labels.

These approaches, for instance, are based on the observation of atypical response to a sensory input; however, challenges with attention is habitually the most regular symptom. Children clinically referred with ADHD use to exhibit sensory over-responsivity, which also make difficult to distinguishes properly between attentional abilities and sensory abnormalities in children under qualitative, behavioural-based analysis. Quantitative approaches are revolutionising SPD diagnostics and treatment by introducing innovative

and synergistic leading-edge technologies to address the present and future needs of children.

## Technology approaches addressing sensory processing disorder (SPD) diagnostics

### Diagnostic boundaries between sensory behaviour and brain activity

According to the American Occupational Therapy Association (AOTA), sensory processing dysfunction (SPD) in the absence of autism spectrum disorder (ASD) in children is estimated to reach 5% in the United States. These children experience SPD, but lack of the primary language dysfunctions and/or social deficits typically meeting conditions for an ASD diagnosis.

One of the most relevant challenges that face children with SPD is the privation of resources for treatment due to an adequate clinical diagnostic label that distinguish from attention-deficit/hyperactivity disorder (ADHD), including ASD. Therefore, measurable biological differences, such as white matter abnormalities noticed in children with SPD that allow profiling sensory dysfunctions play a critical role.

Some researchers, such as Goodman-Scott et al., 2016, observed that a subset of the SPD population may face greater cognitive control deficiencies compared to TDC, particularly cognitive control abilities and specific attention. Some SPD children are less affected by attention deficits, while equally obstructed by sensory dysfunction. Remarkably at this point is that these children are affected by ADHD symptomology, which provides evidence that SPD and ADHD are not identical conditions.

The comprehensive study carried out by Demopoulos et al., 2017, along with the exhaustive hypotheses demonstration published by Anguera et al., 2017, highlights the relevancy of examining cortical auditory and





somatosensory evoked fields in conjunction to performance-based measures of auditory and tactile sensory processing in both ASD and SPD groups, against typically developing children (TDC), as an opportunity to identify aspects of cortical sensory dysfunction to better understand children with SPD who are understudied and have limited access to services despite their significant functional impairment.

These authors together hypothesised that somatosensory response amplitudes would be reduced in the ASD and SPD groups relative to TDC participants. According to the authors, children diagnosed with ASD would exhibit auditory and somatosensory response delays, while children suffering SPD would only present somatosensory response delays.

Hence, cortical auditory response differences could be related to dysfunctions in the communication skills of ASD participants, therefore not affecting children with SPD. Otherwise, impaired tactile performance has been evidenced in both ASD and SPD groups relative to TDC participants, essentially demonstrated by evaluating

their performance on measures of tactile functioning in the ASD and SPD groups.

According to Schoen et al., 2017, more studies linking SPD with direct detailed assessments of cognitive control, including attention, working memory, goal management, and multitasking are crucial for the subsequent development of cognitive solutions to guide SPD treatment. The authors propose the combination of behavioural measures with functional neuroimaging, in addition to an in-depth categorisation of sensory processing and integration challenges associated with SPD.

### **Assessing behavioural markers to target behavioural and neural measurements**

Most effective diagnostic tools use direct behavioural and neural measurements along with parental reports of inattention. Such measurements comprise computerised methods to probe sustained attention, selective concentration, and goal management capabilities. As a diagnostic marker, midline frontal theta power, a recognised electroencephalography (EEG) marker of



attentional abilities proposed by Nigbur et al., 2011, is mostly used to enable the capture in real-time of neural metrics of attention.

One of the most notable observations that these combined methodologies have provided is related to the prevalent issue associated with SPD is the lack of straightaway and efficiently filtering of irrelevant sensory information. As a result, impairment in performance is evidenced, along with and amplified response variability across both sustained and selective attention, and goal management measures.

Anguera et al., 2017, and Alonso and Swadlow, 2017, proposed a unifying theory based on children with combined inattention and SPD have disrupted cortico-thalamic connectivity. Agreeing, the researchers emphasised in that Inhibition-based dysfunction within the basal ganglia may cause a major impact on both thalamic and prefrontal functions, hence delaying discernment abilities that can be revealed in the form of attention based deficiencies in front of a variety of conditions. Measurements based on theta power activity may help to figure out the communication performance between the basal ganglia and frontal regions.

Moreover, modulation of this neural marker following cognitive training would indicate a reduction in children's susceptibility to distraction. Such a statement is also supported by neuroimaging approaches. Children with SPD exhibit a reduction in the white matter microstructural integrity correlated with inattention. In other words, a thalamocortical dysfunction may be responsible for attentional deficiencies in these children. Therefore, training platforms assertive on this impaired circuitry are prone to lead treatment for attention-based deficiencies.

### **Multi-functional smart technology to address sensory processing disorder (SPD) treatment**

#### **Cognitive training intervention targeting attentional abilities**

The development of cognitive training interventions targeting attentional abilities faces particular challenges.

However, a few companies are directly focused on this market niche by developing different technology platforms to help children with SPD to increase their attention and perception performance.

Nuheara, an innovative audio wearables Australian company has developed proprietary hardware and software to deliver multi-functional intelligent assistive hearing technologies that help end users to augment hearing capabilities through smart devices. This company is looking for collaborative research into concentration disorders based on the utilisation of its proprietary IQbuds™ technology to benefit children with auditory processing disorder (APD), autism, sensory processing disorder (SPD) and attention deficit hyperactivity disorder (ADHD).

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**“According to the American Occupational Therapy Association, the 5% of all children suffer from SPD, evidencing overstated aversive, isolation, or exhibiting behaviours associated with sensory inputs.”**

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Nuheara's Super Intelligent Noise Cancellation (SINC™) technology platform and IQbuds™ have reached thousands of people during 2016, so that the company's managers are very optimistic about the potential positive effect on this technology in young children and adults who experience a broad range of concentration and auditory processing issues.

SMARTfit Inc., a California based company, focused on developing multi-sensory approaches to stimulate hands, feet, eyes, and ears terminal nervous receptors, as well as, vestibular and proprioceptors by using game technology, has also directed its attention to the SPD. According to the developers, SMARTfit™ technology may help to rewire the brain. The concept of neuroplasticity is based on the brain's ability to change and adapt and even rewire, as a consequence of certain conditions.

By simultaneously connecting the full body with multiple sensory organs –eyes, ears, feet, hands and vestibular system– more complex cognitive functions are engaged to make decisions and execute skills. Neuroplasticity kicks in naturally, the brain adapts,

skills develop, and overall performance improves. The company realised that the prevalence of sensory over-responsivity (SOR) in elementary school age children is undoubtedly a mainstream issue.

Based on that physical movement is essential to promoting neurological development, the company is ready to focus SMARTfit™ technology to bridge the gap resulting from the lack of natural developmental movements associated with outdoor exploration and sport activity of children of present and future generations.

In a research service recently published by Frost & Sullivan, Janakiranan, it commented that the needs of differently abled students in terms of how smart and intelligent tools supports their education in an efficient way. Children with SPD often find it difficult to communicate with external parties, as the responsiveness level is different, compared to a normal student. Robots are best suited to address this group of student community, as it eliminates the emotional aspect of humans towards repeated teaching.

## Final remarks

According to Frost & Sullivan investigations, the global market for multi-sensory spectrum disorders in children in 2016 reached \$380.8 million. The global market for multi-sensory spectrum disorders in children is expected to rise to nearly \$435.0 million by 2021, growing at a compound annual growth rate (CAGR) of 2.7% from 2016 to 2021.

Frost & Sullivan's analyses reflect the relevancy of quantitative methods of diagnosis, which have enabled the derivation of thalamocortical dysfunction as potentially responsible for attentional deficiencies in children with SPD. The present findings also underscore a paradigm shift in the understanding of neurodevelopmental disorders, as a continuous series of symptoms instead of an isolate discrete condition. This new point of view has allowed achieving more promising, targeted intervention outcomes in children with SPD.

The smart combination of behavioural-based approaches to neuroscience development will lead to

customised intervention options that will maximise benefit for children.

## Acknowledgements

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**Cecilia Van Cauwenberghe, PhD, MSc, BA**  
Associate fellow and senior industry analyst

TechVision Group, Frost & Sullivan  
cecilia.vancauwenberghe@frost.com  
ww2.frost.com  
www.twitter.com/Frost\_Sullivan

# Implementing digital technology for brain health

Frédéric Destrebecq, Vinciane Quidbach and Marijn Scholte from The European Brain Council (EBC) detail how the future of healthcare and improved brain health can be achieved through implementing digital health technology

The European Brain Council (EBC) is a Brussels-based organisation that gathers patient associations, major brain-related societies, as well as industries, with a mission to promote brain research in Europe to improve the quality of life of those living with brain disorders in Europe. As they join the eHealth conversation and digital technologies continue to develop at a rapid pace, plus the fact that the use of health data continues to widen, EBC firmly believes that the future of healthcare and improved brain health can only be achieved through implementing digital health technology that is properly designed. EBC, therefore, aims to join the forerunners in the digital movement. Brain health's digital future is clearly on its way.

Brain disorders are highly prevalent and disabling diseases and represent a tremendous burden on European society. A cost study conducted by the European Brain Council (EBC) in 2011 underlined that more than 1 in 3 Europeans, i.e. 179 million people, are likely to be affected by a disorder of the brain, the treatment of which is estimated to cost close to €800 billion annually<sup>1</sup>. Psychiatric and neurological disorders, ranging from schizophrenia, anxiety and Alzheimer's disease, to Parkinson's disease, epilepsy and multiple sclerosis, are the root of many chronic diseases<sup>2</sup> and represent 35% of the burden of all diseases in Europe<sup>3</sup>.

Despite the unprecedented scientific progress made in recent years, there is still no cure for a wide range of brain disorders, though effective treatments do enable faster recovery and better outcomes. Against this backdrop, EBC recently launched a Policy White Paper on the "Value of Treatment (VoT) for Brain Disorders in Europe", which provides a series of policy recommendations to address the unmet medical needs of people living with brain conditions. The VoT study highlighted the importance of using eHealth tools for solving issues

associated with treating brain disorders and that the proliferation of digital health tools, including mobile health apps and wearable sensors, has the potential to greatly improve the prevention and management of brain disorders<sup>4</sup>.

EBC aims to further explore the potential of eHealth for addressing challenges associated with brain disorders and has in this context contributed to the drafting of the Digital Health Society Declaration<sup>5</sup> and provided input to the public consultation on Health and Care in the Digital Single Market. It is crucial for organisations, such as EBC, that a Europe-wide regulatory framework gets implemented, allowing stakeholders to fully harness the advantages of digitalisation.

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**"...it is important that decision-makers set clear future policy objectives in the domain of digital health and further explore opportunities for progressing the digital transformation of care delivery, to the benefit of millions of Europeans living with brain disorders."**

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In this regard, EBC believes policymakers need to prioritise action in a certain number of areas such as health data sharing, mobile interventions or digital literacy. A recent report highlighted several potential benefits associated with the use of health data for research purposes, such as reduced duplication of research, the greater external validity of research and more opportunities to reveal patterns of causation (a result of linking datasets)<sup>6</sup>.

Additionally, a recent publication in the Journal of Medical Internet Research underlined the potential of applications and SMS text messaging for reducing symptoms of stress, depression and anxiety and highlighted the need for further investigation<sup>7</sup>. Finally,





healthcare professionals need to have the required ICT skills to successfully use digital solutions and therefore eHealth should become part of the curricula of healthcare providers.

These examples are few of many digital solutions and focus areas that can change the way in which healthcare is provided and highlight some of the potential advantages that digital health is likely to provide for the benefit of patients and society at large. In this regard, it is important that decision-makers set clear future policy objectives in the domain of digital health and further explore opportunities for progressing the digital transformation of care delivery, to the benefit of millions of Europeans living with brain disorders. ■

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**Frédéric Destrebecq**  
**EBC Executive Director**

**Marijn Scholte**  
**Policy Officer**

**Vinciane Quoidbach**  
**Public Health and Policy, Research Project Manager**  
The European Brain Council (EBC)  
Tel: +32 (0)2 513 2757  
[www.braincouncil.eu](http://www.braincouncil.eu)  
[www.twitter.com/eu\\_brain](https://twitter.com/eu_brain)

# MRI and MEG imaging of human sensory disorders

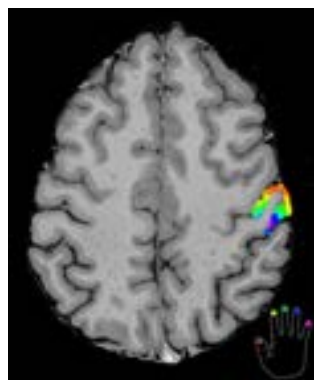
Professor Susan Francis of the Sir Peter Mansfield Imaging Centre, University of Nottingham explores how state-of-the-art imaging methods can be used to study human sensory disorders (the sense of touch)

The somatosensory system transmits nerve impulses pertaining to tactile, proprioceptive, thermal, nociceptive and affective sensations. There have been significant advances over the past few years, from genetic labelling studies to development of brain-computer interfaces for neuroprosthetics that are changing the way we think about the role of the somatosensory system in health and disease.

Our research is focussed on understanding the neuroscience that underlies human tactile processing, using state-of-the-art imaging methods to gain a greater understanding of how the brain processes somatosensory input, how somatosensory processing is altered in clinical conditions and the effect of therapeutic interventions. Outcomes of this research will facilitate the diagnosis and development of new treatment strategies for a wider range of peripheral and central somatosensory neurological disorders.

## Understanding the neuroscience of tactile processing

The sense of touch is something we take for granted; we grasp objects without thinking, open doors, recoil when we pick up something that's hot. Despite this fundamental mechanism, the sense of touch is still relatively poorly understood, with many significant knowledge gaps in the neuroscience underlying human tactile



*Figure 1: Example image showing how the brain maps the fingers of the hand (shown by each individual colour) in the primary somatosensory cortex. We plan to explore how this mapping is altered in clinical conditions such as focal hand dystonia*

processing. The skin permits the sensations of touch, heat and cold, containing a wide range of sensory receptors that receive stimuli and inform the brain about the events occurring on the body surface through an extensive system of sensory nerves.

To improve understanding of the precise mechanisms involved in sensory processing, it is necessary to first understand the signal changes that occur in the brain. However, the mechanism that underlies our sense of touch involves relatively small changes in signal intensity in small brain regions, the somatosensory system, making it difficult to track the changes and elucidate understanding. This project employs cutting-edge techniques and multidisciplinary approaches to improve understanding of somatosensory pathways.

Here we use functional magnetic resonance imaging (fMRI), which enables

the measurement of the increase in signal intensity in the part of the brain that is active in response to touch. However, because the changes in the signal intensities involved in touch are so small, it is difficult to use standard fMRI methods to map the changes that occur in response to touch with sufficient spatial resolution. For this reason, we use ultra-high field fMRI (UHF-fMRI) using a 7 Tesla MR scanner to form very high spatial resolution maps of the functional architecture of individual human brains.

Our group has previously used UHF-fMRI to form spatial maps of how individual fingers are mapped within the primary somatosensory cortex of the human brain, Figure 1, and the finer somatosensory sub-areas previously only defined by histology. We now plan to publish a probabilistic atlas of the representation of the fingers in the primary somatosensory cortex and to show how these sensory maps

are altered in the brains of patients with clinical conditions. We will also use ultra-high submillimetre spatial resolution fMRI to assess cortical microstructure and unravel the functional organisation of the cortex at the level of the six cortical layers to assess feed forward and feedback connectivity.

**“Our research is focussed on understanding the neuroscience that underlies human tactile processing, using state-of-the-art imaging methods to gain a greater understanding of how the brain processes somatosensory input, how somatosensory processing is altered in clinical conditions and the effect of therapeutic interventions.”**

Another method the project is employing is magnetoencephalography (MEG). This is a non-invasive neuroimaging technique that measures magnetic fields at the scalp surface from which brain activity can be mapped. Using MEG, activity in local neuronal populations can be inferred and facilitate the assessment of long-range communication between cortical regions with unprecedented temporal resolution. The combination of UHF-fMRI and MEG data yields cortical mapping with uniquely high spatial and temporal precision allowing the assessment of how brain function is altered between healthy controls and patients.

For a further understanding of the neuroscience of touch, the project collaborates with Professor Johan Wessberg and colleagues from University of Gothenburg, Sweden on the use of intraneural microstimulation (INMS). In INMS, a single nerve fibre can be stimulated electrically using a very small current. This involves inserting an extremely fine needle through the skin and into an underlying nerve,

allowing unprecedented access to the earliest stages of information transfer to the brain. This effect enables a person to feel touch without there being any actual skin stimulus. By combining INMS with neuroimaging techniques of UHF-fMRI and MEG, it is possible to resolve the significance and impact of single sensory nerve inputs and bridge an important scientific and clinical gap between input codes in mechanosensitive afferents and their dynamic interaction to generate a percept.

Neurological disorders are the most common cause of disability, with 10 million sufferers in the UK. Disturbances of somatic sensation are a major contributor to such disability. Specifically, in this project, we are studying the two clinical conditions of focal hand dystonia and carpal tunnel syndrome, which have been specially selected to provide new understanding of somatosensory neuropathology. We plan to use UHF-fMRI to assess how finger representations are altered in somatosensory and motor cortex regions and how the brain re-maps following therapeutic interventions. Sensory deficits are prominent in several conditions, including neuro-traumatic injury, neurodegeneration and complex regional pain syndrome. The results expected might help to identify the underlying neuronal mechanisms and to develop novel treatments, improving the lives of many in the process.

## Final remarks

Using UHF-fMRI and MEG we aim to advance understanding of human somatosensation and perception. We aim to address how the brain encodes and integrates touch and how the patient's brain re-maps various motor and somatosensory pathways.

These projects are performed in collaboration with University of Gothenburg, Sweden (Lead: Professor Johan Wessberg) and Liverpool John Moores University (Lead: Professor Francis McGlone) and are funded by the Medical Research Council (Grant number MR/M022722/1).

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## Professor Susan Francis Professor

Sir Peter Mansfield Imaging Centre,  
University of Nottingham  
Tel: +44 115 846 6518  
susan.francis@nottingham.ac.uk  
www.nottingham.ac.uk/research/groups/  
spm/c/  
www.nottingham.ac.uk/research/groups/  
spm/c/research/touch-map/





# The broad and diverse medical technology sector

Jonathan Evans, communications manager at the Association of British Healthcare Industries explores the broad and diverse MedTech sector as it stands today

**T**he Medical Technology (MedTech) sector is broad and diverse. There are thousands of products on the market, from wound care dressings, needles and syringes, pacemakers, knees and hips, MRI scanners and blood pressure monitors. The products made are integral to the delivery of modern healthcare and the chances are, we will all need MedTech at some point throughout our lives.

The sector is driven by innovation and underpinned by strict regulation. Products are developed to target a specific need, be it the need to do something faster or more efficiently, cleaner or more cost-effectively.

In the UK alone, MedTech employs close to 100,000 people, generating a collective turnover of £17 billion. Representing this sector is ABHI, the MedTech trade association. ABHI and its members champion the use

of safe and effective MedTech, to support health system efficiency and crucially, high-quality patient outcomes. When we consider the advancements in technology, MedTech has the potential to revolutionise the delivery of healthcare as we know it.

In the global context for healthcare, the UK's differentiating factor is the National Health Service (NHS). As the fifth largest employer in the world, it is comfortably the biggest single-payer health system. It can be a superb test-bed for innovative technologies, yet the system is under great pressure. With an ageing population comes a steady rise in chronic conditions and for some time now, funding for the NHS has not matched the complex health needs of the country.

With tight budgets, there is a natural shift to cost-saving measures. Unfortunately, this often means buying the



One ABHI member tells us that just one of their products crosses eight borders before completion. For suppliers to be able to move their products across borders, there needs to be practical measures in place to ensure the supply of products to a patient is uninterrupted. Without this, there is a very real danger of delayed supply, which will hit patients the hardest.

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**“The Medical Technology (MedTech) sector is broad and diverse. There are thousands of products on the market, from wound care dressings, needles and syringes, pacemakers, knees and hips, MRI scanners and blood pressure monitors. The products made are integral to the delivery of modern healthcare and the chances are, we will all need MedTech at some point throughout our lives.”**

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cheapest available product. However, the cheapest product does not always mean the best overall value. A product that has a longer shelf life, is more durable and of a higher quality, may cost fractionally more per unit, but will have better outcomes for the patient or system. This, in turn, leads to far greater cost savings in the long run. Added to this is the issue of patient safety. When it comes to providing safe and effective solutions to patients, results should be driven, first and foremost, by outcomes.

This view was recently echoed by the former Medical Director of NHS England, Sir Bruce Keogh. In a 2017 interview with the Daily Telegraph, he said too many hospitals were putting cost-cutting ahead of patient safety. “People accept that their disease has risks, they accept that the treatment may carry some risks. What they should never have to accept is that the way we design and deliver our services adds to that risk,” he said.

Added to the NHS’s challenges, the impact of Brexit must be monitored closely. MedTech products, like those in many other sectors, rely on international supply chains. Meaning that products are moved to different countries for material sourcing, manufacturing, packaging and sterilisation. It is not uncommon for a “British” product to have touched several jurisdictions before reaching the market place.

For patients’ to be able to access the best in cutting-edge technology, that is not just safe and effective, but also provides genuine value to the system, collaboration will be key. There is a real opportunity for the NHS to capitalise on manufacturing advances. It has the wide-reaching platform to create a collaborative environment where industry and the health system work together to advance the provision of healthcare and safety for patients.

Naturally, there is always room for safety improvements, but the MedTech industry seeks to work closely with patients to better understand the factors which increase adverse events and to develop solutions that are patient-centered. In every step of the pathway, MedTech can help. Prior to admission into a hospital with advanced diagnostic technologies, right the way through to discharge, where patient monitoring devices play a significant role. ■

### **Jonathan Evans**

#### **Communications manager**

Association of British Healthcare Industries

Tel: +44 (0)20 7960 4360

[enquiries@abhi.org.uk](mailto:enquiries@abhi.org.uk)

[www.abhi.org.uk](http://www.abhi.org.uk)

[www.twitter.com/UK\\_ABHI](https://twitter.com/UK_ABHI)

# Transmission electron microscopy (TEM) to see ‘functionalities’ and ‘material property interactions’

Senior researcher at Center for Electron Nanoscopy at DTU CEN, Takeshi Kasama reveals the institution's expertise around transmission electron microscopy (TEM)

**T**ransmission electron microscopy (TEM) involves the use of high-energy electrons that have passed through a thin specimen to record images, diffraction patterns or spectroscopic information. Many different TEM techniques have been developed over the years into highly sophisticated methodologies that have found widespread application across many scientific disciplines.

Since the TEM has an incomparable capability to provide structural and chemical information over a range of length scales down to atomic dimensions, it has developed into an essential tool for researchers who are interested in understanding the properties of nanostructured materials and in manipulating their behavior. Besides the conventional TEM techniques, TEM offers a unique opportunity for imaging ‘functionalities’ and ‘material property interactions’ at the nanoscale. Electron holography allows magnetic and electrostatic fields in nanostructured materials to be recorded quantitatively at a high spatial resolution down to ~5 nm, while Lorentz microscopy can be used to image their dynamical changes from large areas of interest<sup>1</sup>. Figure 1 demonstrates a magnetic induction map of a ferromagnetic CoPd nanoparticle encapsulated in a multi-walled carbon nanotube recorded using electron holography, which may recall a



magnetic flux pattern formed using a bar magnet and iron filing.

One of the scientifically attractive systems is the switching of material properties by the interplay between magnetism, electricity and elasticity (e.g., multiferroicity). Magnetite, which is a naturally occurring multiferroic mineral, undergoes a first-order phase transition below ~125 K, known as the Verwey transition, from a cubic structure to a closely related monoclinic structure. The loss of the symmetry results in the formation of ferroelastic transformation twins, which consequentially produce spontaneous strains.

Electron holography and Lorentz microscopy were used to understand local interactions of ferrimagnetic domain walls with the ferroelastic twin walls<sup>2</sup>. Figure 2 shows that magnetic domain walls appear reproducibly at the same positions after applying external fields to the specimen by partial excitation of the microscope objective lens, suggesting that the positions of the magnetic domain walls are defined strictly by underlying nanoscale twin domain walls.

The magnetic imaging techniques have also been applied to geoscience-related subjects, such as how rocks record magnetic fields and retain them

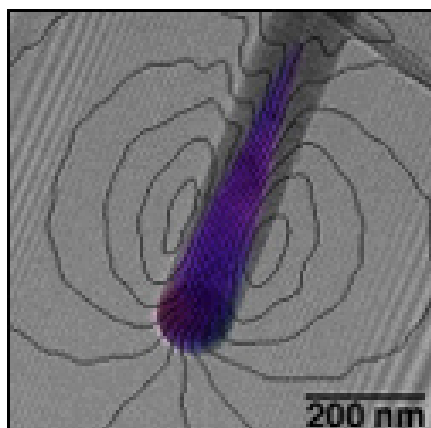


over a geological timescale. In many cases, geological samples contain different magnetic minerals and/or magnetically different phases even though they are the same mineral. TEM can obtain local magnetic information from individual magnetic phases and correlate the magnetic characteristics directly with other physical, chemical or geometrical properties.

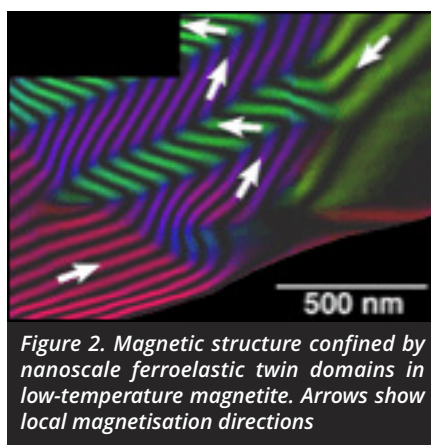
**“Since the TEM has an incomparable capability to provide structural and chemical information over a range of length scales down to atomic dimensions, it has developed into an essential tool for researchers who are interested in understanding the properties of nanostructured materials and in manipulating their behavior.”**

Electron holography was used to elucidate magnetic mineral's ability to retain the past magnetic field that existed when our solar system was formed<sup>3</sup>. Nanometre-scaled tetrataenite was magnetically stable enough for maintaining the acquired magnetic fields and had recorded the magnetic information along the axis of time as if it was a magnetic tape recorder<sup>3,4</sup>.

What is coming next? At DTU-Cen, we are especially interested in observing ‘functionalities’ and ‘dynamic behavior’ in actual reaction environments. Electron holography and Lorentz microscopy in gas atmospheres using environmental TEM or liquids would open a new avenue to nanoscale magnetic research that had not been considered until recently. The combination of the magnetic imaging and environmental TEM allows us to study how redox modifies magnetic structures



**Figure 1. Magnetic image of a CoPd magnet in a carbon nanotube measured by electron holography**



**Figure 2. Magnetic structure confined by nanoscale ferroelastic twin domains in low-temperature magnetite. Arrows show local magnetisation directions**

along with the material phase and composition in desired atmospheric environments<sup>5</sup>.

The validity of in-situ liquid-cell electron holography to the detection of magnetic and electrostatic fields has been proven in a few groups including DTU-Cen. This technique would provide opportunities to investigate magnetic interactions between nanoparticles in liquid and magnetisation evolutions during crystal growth and dissolution. Thus, the magnetic imaging would become a more attractive tool for studying local magnetic properties in actual environments and device's work-

ing conditions and could be used in broader research fields, such as material science, geoscience, environmental science and medical and biological applications.

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**DTU Cen**  
Center for Electron Nanoscopy

**Takeshi Kasama**  
Senior researcher  
DTU CEN – Center for Electron Nanoscopy  
Tel: +45 4525 6475  
takeshi.kasama@cen.dtu.dk  
www.cen.dtu.dk  
www.danchip.dtu.dk  
www.twitter.com/dtu\_danchip\_cen

# The role of geography in addressing global health needs

Senior Research Advisor from the American Association of Geographers, Yonette Thomas discusses the important role that geography can play in addressing global health needs, both in research and in practice

The American Association of Geographers (AAG) is a non-profit scientific and educational society, founded in 1904. For over 100 years the AAG has contributed to the advancement of geography and added to this, its members come from nearly 100 countries and share interests in the theory, methods and practice of geography.

Introducing the fascinating subject of health geography, the AAG's senior research advisor, Yonette Thomas points out that human geography involves the interaction between human beings and their environments in place, time and spatially defined areas. Having said that, the subject of health adds to this type of geography because where people reside and live impacts their health and wellbeing. Thomas then goes on to expand this fascinating point in her own words, such as what diseases impact upon people, how their physical environment impacts their health.

"Geography and health, have a long conceptual and methodological history. Medical geographers focus on the interaction of health and geography and bring these two areas together. This focus on the geography of health and disease is multi-disciplinary because, for example, medial sociologists and social epidemiologists study people in context from an ecological perspective and engage health geographers in such studies. We know and have evidence for understanding how where people live and reside directly impacts their health, what kind of food they eat and how active they are. This is a multi-disciplinary effort requiring shared conceptualisations and methodologies."

"More specifically, examining broader perspectives in terms of environments and physical location, or country-by-country right down to municipalities and



neighbourhoods, is where the action really happens. If we look at the City of London during the time of John Snow, people were fetching water from the Broad Street pump when the cholera epidemic was raging. John Snow, the father of modern epidemiology, is famous for removing the Broad Street pump and halting the cholera epidemic.

"When you look at lower and middle-income countries (LMICs) in the world today – such as in Bangladesh and other countries where people are moving into urban areas or forced into migration because of wars or famines – the knowledge and tools of health geography help us understand and implement strategies for dealing with the consequences of these events. So geographers play a significant role in using tools such as geographic information systems (GIS) to map out water resources, sanitation control points, food sources, where crops are better grown in relation to where population groups are and where people are at risk."

Having looked at these intersecting pieces, Yonette then underlines that health geography does not only inform issues affecting populations in low and middle-income countries, but in developed countries such as the United States as well. In the United States an opioid epidemic is significantly affecting certain population groups. For example, people in working class communities like Kennett, Missouri, a state in the Midwestern United States, who worked in the factories, are white, and experienced privilege are bearing the brunt of the opioid crisis, Yonette explains before telling us about this point further.

“The factories have moved from those areas, so people are out of work and are not only on pills, but suffer chronic conditions such as diabetes, metabolic syndrome and cardiovascular disease. The fact that there are few doctors to provide care to the affected in many of these towns has created an access to care issue. This presents an example of a collaboration opportunity for public health researchers, health professionals, and health geographers to work with state and local entities.

Geographers play an important role in collaborating with epidemiologists, public health professionals and researchers, professionals in sectors such as the transportation sector, or with those who focus on water and food security. Geographers add spatial understanding to public health challenges. Context and environment are fundamentally important, particularly how they impact health.”

Having looked at the significance of health geography in the world today, Yonette is keen to share her thoughts on the important role that geography can play in addressing global health needs, both in terms of research and practice and impacting policy. When it comes to understanding the dynamics of global health, we are witnessing the rapid movement of people from rural into urban areas and new urban areas are being established whether the infrastructure is ready for them or not, Yonette tells us.

“We see this happening in places such as China, Bangladesh, India and Africa and so geography can help policymakers and those at the national, sub-national and municipality levels to prepare for and respond to the dynamic movement of population groups and to identify, for example, where key sources of sanitation and water should be located. They play a role in helping

global and urban health professionals map out and locate where infrastructure needs to be to respond to this movement of people and related health issues.

If you look at Sustainable Development Goals 3 and 11, for example, they rely on fundamental tools of geography in helping us to understand the dynamic movement of people and how we respond. Infrastructure informed by research and practice should, therefore, be put in place to prevent, intervene and treat disease conditions and maintain health.”

The conversation then moves towards Yonette’s thoughts on the priorities for research in the field of health geography. She explains that much research is taking place today, indeed this is the bread and butter of academics such as Yonette. She underscores that: “where we are falling short is in the active translation of that research into practice and policy”.

In closing, Yonette firmly underlines that now is a very exciting time for health geography and that journals such as Open Access Government can make a call for action to policy-makers, researchers and people on the ground to actively translate what we already know into both practice and policy.

“Practitioners and other professionals are out there implementing phenomenal programmes – but what really needs to happen in the 21st century is a specific focus on how we are translating what we know into programming, practice and infrastructure development and policymaking on the ground.

“If you use the example at the country level, the minister of health is not as important as the minister of finance. Health issues can get lost in the mix because other things take precedence. So, we need to target health from a policy-making, infrastructure development and economic value perspective, so a prime minister must realise that the health of her/his population will ensure the economic health of the country and vice-versa.” ■

**Yonette Thomas, PhD**  
**Senior Research Advisor**

American Association of Geographers

Tel: +1 301 758 4407

[ythomas@yftomasdr.com](mailto:ythomas@yftomasdr.com)

[www.aag.org](http://www.aag.org)

[www.twitter.com/theaag](https://www.twitter.com/theaag)



# Improving the health and wealth of the UK through research

The National Institute for Health Research (NIHR) aims to improve both the health and wealth of the UK by means of research, as Open Access Government's Editor Jonathan Miles discovers

**N**ational Institute for Health Research (NIHR) is funded by the UK's Department of Health and ultimately aims to improve both the health and wealth of the UK by means of research.

The NIHR's mission is essentially to provide a health research system, as we find out on their website, in which, "the NHS supports outstanding individuals working in world-class facilities, conducting leading-edge research focused on the needs of patients and the public."<sup>1</sup>

In summary, the NIHR:

- Funds high-quality research to better health;
- Supports and trains health researchers;
- Provides world-class facilities for research;
- Cooperates with charities and the life sciences industry to benefit all and;
- Involves both patients and the public every step of the way.

Going into more detail, the reason why NIHR funds health and care research is so that it translates into actual discoveries for practical products, devices treatments and procedures that concern both patients and the public.

NIHR ensures that the NHS can support the research of other funders to encourage wider investment in and economic growth from, health research. NIHR works with both the life sciences industry and charities to help patients gain access to breakthrough treatments as early as possible. In addition, NIHR both trains and

develops researchers to ensure that the UK stays at the forefront of the international research scene.

According to the NIHR, the future of health and social care in the UK depends on the research of today. With perhaps the most integrated clinical research system in the world, the NIHR believes that the UK drives research from bench to bedside to ultimately benefit both patients and the wider economy.

## Research Integrity Concordat

Something that underpins the organisation's work is the Research Integrity Concordat. This specifically sets out commitments that provide assurances to the UK government, the wider public and the international community that research in the country is always underpinned by the highest standards of integrity and rigour.

Developed in collaboration with the funding and research councils, Wellcome Trust and various government departments, the concordat sets out to:

- Provide better coordination of existing approaches to research integrity;
- Enable more effective communication of efforts to ensure that the highest standards of rigour and integrity continue to underpin all NIHR's research;
- Encourage greater transparency and accountability at both institutional and sector levels and;
- Stimulate reflection on current practices to identify where improvements can happen.

## Recruiting patients for research

In recent news on the NIHR website, we discover that



Stroke specialists at the North of Tyne's hyperacute stroke research centre (HSRC), based at Newcastle's RVI were recently commended as a leading specialist centre in stroke research, following a peer review led by experts from the NIHR. Newcastle was particularly noted for 'its brilliant recruitment contributions', having experienced the highest number of patients taking part in trial participation in the UK, and in a broader range of complex clinical trials than other centres.

Dr. Anand Dixit, the CRN NENC Specialty Lead for Stroke who works as a stroke specialist at the RVI says: "Typically these decisions are taken based on advanced brain imaging and can only be carried out in selected centres in the country such as here in Newcastle. We are currently delivering trials testing novel clot retrieval devices, drugs for the treatment of stroke and stem cell therapies following a stroke."

Dr. Dixit, also says that Newcastle's performance is due to the positive engagement of the whole clinical team in research participation. He then explains this interesting point in further detail: "We have a unique approach towards ensuring that every single member of our clinical team treating hyperacute stroke is research active. This means we do not miss an opportunity to offer pioneering interventions to all our patients. Our approach of clinical and research integration helps us to offer these interventions to a larger number of stroke patients giving them chance of maximum recovery."

NIHR's National Specialty Lead for Stroke, Professor Tom Robinson adds that The North of Tyne have performed exceptionally well, something he believes is a testament to both the enthusiasm of the research team and its leadership. "The engagement of clinical staff, and the strong support that the HSRC receives from the local Clinical Research Network (CRN) and the Trust. It is also important to note the North of Tyne's HSRC's contribution of academic studies to the HSRC portfolio as well, notably PASTA", he underlines.

Many more excellent examples of the research that NIHR funds is available on their website, including the mental health of pregnant women and helping truck drivers get their health back on the road. Whatever the area of research is, there is no doubt that ultimately it improves the health and wealth of the UK in many positive ways. ■

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#### **Jonathan Miles** **Editor**

Open Access Government  
Tel: +44 (0)1270 502 874  
[www.openaccessgovernment.org](http://www.openaccessgovernment.org)

# AAV: From almost a virus to an awesome vector for human gene therapy

Dr. Arun Srivastava, George H. Kitzman Professor of Genetics, from the University of Florida describes the rationale and strategies for the development of next generation (NextGen), generation X (GenX) and optimised (Opt) recombinant AAV vectors for human gene therapy

**R**ecombinant AAV vectors have been, or are currently being, used in 165 Phase I/II clinical trials (and one recent Phase III trial) in humans and thus far, no serious adverse events have ever been observed or reported. AAV2 vectors have shown clinical efficacy in three human diseases: Leber's congenital amaurosis (LCA), aromatic L-amino acid decarboxylase deficiency (AADC) and choroideremia. In the past decade, at least 12 additional AAV serotype vectors have also become available. AAV1 vectors have successfully been used in the gene therapy of lipoprotein lipase deficiency (LPL) and  $\alpha$ 1-antitrypsin deficiency (AATD); and AAV8 vectors have shown clinical efficacy in haemophilia B; AAV5 vectors in haemophilia A; and AAV9 vectors in spinal muscular atrophy (SMA) and Pompe disease. The AAV1-LPL vector was approved as a drug, designated as Alipogene tiparvovec and marketed under the trade name Glybera®, in Europe in 2012.

In 2017, an AAV2 vector expressing retinal pigment epithelium-specific 65 kDa protein (RPE65) was licensed as a drug, Voretigene Neparvovec (Luxturna), in the USA. Additional Phase I/II clinical trials are currently being pursued with AAV1, AAV2, AAV3, AAV5, AAV6, AAV8, AAV9 and AAV10 vectors for the potential gene therapy of a wide variety of human diseases.

Despite these remarkable achievements, it has become increasingly clear that the full potential of AAV vectors composed of the naturally occurring, wild-type (WT) capsids and genomes is unlikely to be realised for the reasons outlined below.

## **AAV capsid is targeted for degradation by the host cell enzymes**

Since the wild-type [WT] AAV did not evolve for the purposes of delivery of therapeutic genes, recombinant AAV vectors composed of naturally occurring capsid are unlikely to be optimal in human clinical trials. Dr. Srivastava's laboratory made the original observation that following infection of cells, only ~20% of the input AAV2 vectors gain entry into the nucleus, whereas ~80% fail to escape the endosome in the cytoplasm. It was subsequently reported that AAV2 capsids become ubiquitinated in the cytoplasm, where they are targeted for degradation by the host cell proteasomal machinery, thereby negatively impacting the transduction efficiency of the first generation of AAV vectors.

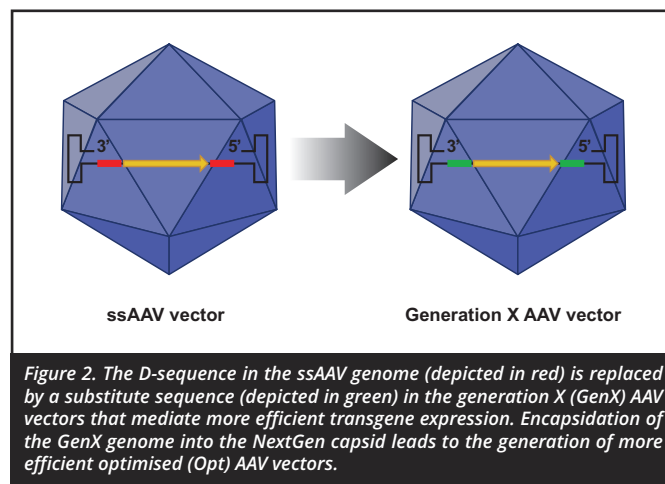
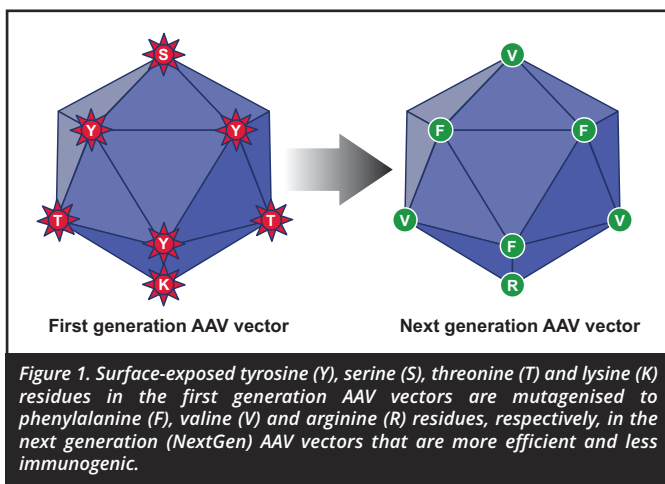
The WT AAV2 capsid contains specific amino acid residues (7 tyrosines {Y}, 17 serines {S} and 15 threonines {T}) that are surface-exposed and are targeted for phosphorylation by the host cell protein kinases. In addition, AAV2 capsid also contains seven surface-exposed lysine (K) residues, which are

ubiquitinated. These modifications render a large fraction of first generation of AAV vectors for degradation by the host cell proteasome machinery. Each of these surface-exposed Y, S, T and K residues were mutagenised in Dr. Srivastava's laboratory to generate the next generation (NextGen) of AAV vectors with improved intracellular trafficking to the nucleus and consequently, high-efficiency transduction.

Interestingly, most, if not all, of the surface-exposed Y, S, T and K residues are highly conserved among all 10 commonly used AAV serotype vectors and most of these residues have also been mutagenised in each of the 10 AAV serotype vectors. Thus, the capsid-modified next generation of AAV vectors, as schematically illustrated in figure 1, overcome some of the limitations associated with the first generation of AAV vectors.

In this context, it is important to point out that three Phase I/II clinical trials with one of these tyrosine-mutant AAV2 vectors have been initiated and the initial results appear very promising. In one trial, 13 of 14 patients with Leber's hereditary optic neuropathy (LHON), who were administered this vector intravitreally, showed improvement in visual acuity up to 24-month follow-up, without any loss of vision or any serious adverse events. Thus, the capsid-modified next generation of AAV serotype vectors will prove to be





far more efficacious than their WT counterparts in human gene therapy.

### The single-stranded AAV genome is transcriptionally-inactive

The WT AAV genome is a single-stranded DNA and single-stranded DNA of both [+] and [-] polarities are encapsidated into separate mature virions with equal frequency. While inconsequential for the WT AAV, which remains latent in host cells, the single-stranded DNA of a therapeutic gene in an AAV vector is problematic, since single-stranded DNA is transcriptionally-inactive and viral second strand-DNA synthesis is a rate-limiting step during AAV vector-mediated transgene expression.

Dr. Srivastava's laboratory identified that FKBP52, a well-known cellular chaperone protein that binds the immunosuppressant drug FK506, interacts specifically with the single-stranded sequence of 20 nucleotides, termed the D-sequence, within the AAV inverted terminal repeat (ITR) at the 3' -end of the viral genome and strongly inhibits the viral second-strand DNA synthesis, resulting in impaired transgene expression. In nearly all clinical trials performed thus far have utilised ssAAV vectors and yet clinical efficacy has been observed in

several human diseases, as outlined above.

Dr. Srivastava hypothesised that substitution of the D-sequences from the viral genome would allow more efficient viral second-strand DNA synthesis and consequently high-efficiency transgene expression. However, both D-sequence-substituted AAV genomes failed to undergo encapsidation. Interestingly, when only one of the two D-sequences was substituted from the AAV genome, successful encapsidation ensued and the efficiency of transgene expression from the D-sequence-substituted AAV genomes was significantly higher than that from their unmodified counterparts. These genome-modified vectors, designated generation X (GenX) AAV vectors are depicted schematically in figure 2.

Further studies revealed that the D-sequence at the 5' -end in the viral ITR contains the binding site for a cellular NF-κB repressing factor (NRF), which inhibits viral transgene expression. Thus, the genome-modified GenX AAV vectors partially overcome the limitation associated with the conventional ssAAV vectors.

More recent studies from Dr. Srivastava's laboratory have documented that when the modified AAV genomes

are encapsidated into the modified capsids, the resulting optimised (Opt) AAV vectors transduce cells and tissues significantly more efficiently at 20-30-fold further reduced doses. Thus, the NextGen, GenX and Opt AAV serotype vectors circumvent the problems associated with the first generation of AAV vectors, in addition to being far more efficacious, less immunogenic and more cost-effective.

Plans are currently underway to use one of these NextGen AAV vectors to initiate a Phase I clinical trial in humans in a three-way collaboration among Christiann Medical College in India, and Emory University and University of Florida in the USA.



#### Dr. Arun Srivastava PhD

George H. Kitzman Professor of Genetics  
University of Florida  
Tel: +1 352 273 8259  
aruns@peds.ufl.edu  
<http://research.pediatrics.med.ufl.edu/researchers/research-faculty/arun-srivastava/>

# Physical Activity and Nutrition Influences In ageing (PANINI)

Prof. Anna C. Whittaker from University of Birmingham's School of Sport, Exercise & Rehabilitation Sciences looks at the need for ageing research in Europe

**C**urrent demographic trends indicate that by the year 2020, almost 1 in 5 of the European population will be aged 65 years or over. Although life expectancy is increasing by 2 years per decade, the period of life spent in good health (health span) is not keeping pace with lifespan. Most Europeans spend their last decade in poor health, making ageing research an urgent priority in Europe.

Consequently, there is a pressing need to understand how lifestyle factors can influence age-related changes. Research to gain this understanding will need to focus on gene level to society level to encompass the many impacts of lifestyle and how these effects interact to influence healthy ageing.

It is also crucial to develop and test interventions to ensure more older adults have a healthy later life. The Horizon 2020 funded Marie Curie-Sklodowska Innovative Training Network – PANINI is addressing these issues through focusing research training on two major interacting lifestyle factors, namely physical activity and nutrition.

## Why are physical activity and nutrition important?

Physical activity and optimal nutrition can influence the function of a range of body systems, which interact in the maintenance of health via enhancing

quality of life, mental abilities, and muscle mass, decreasing fat mass and modifying sarcopenia (loss of skeletal muscle mass and function).

However, data are sparse on energy intake and energy expenditure in less fit or frailer older populations. Consequently, nutritional and exercise requirements of elders to maintain physical and mental function are not fully understood, although the European Society for Clinical Nutrition and Metabolism have made evidence-based nutrition recommendations and the European College of Sport Science have adapted existing physical activity guidelines for older adults.

## Who is PANINI?

PANINI is a research training network led by Prof. Anna Whittaker at the University of Birmingham and consists of leading academic and non-academic research institutions across Europe. Our partners are private sector companies working on physical activity or nutrition products, healthcare organisations, ageing charities and policy makers.

## What will PANINI do?

1. Stimulate collaborative ageing research across Europe from basic science to clinical intervention on physical activity and nutrition;
2. Develop a standardised toolkit of best practice measures of physical activity and nutrition for use with older adults;

3. Use the toolkit across PANINI projects to develop a shared dataset across different European ageing populations;

4. Compare novel physical activity and nutritional interventions to improve healthy ageing and;

5. Create a healthy ageing policy document with key stakeholders.

## What will PANINI need to research?

To promote healthy ageing, it is important to understand the mechanisms underlying unhealthy ageing. Ageing is a complex process and age-related changes in physiological systems often interact to influence our function. For example, increased fat mass but declining muscle mass and function, weight loss, fatigue, weakness, slow walking speed and physical inactivity are often overlapping changes with age and combine to result in frailty and poorer well-being.

Consequently, early detection of frailty or the risk of frailty through multi-disciplinary assessment of a range of relevant factors and sensitive biomarkers and mitigation through targeted interventions is essential. Physical activity and nutrition have been suggested as primary drivers of health and physical function in later life.

PANINI is covering a range of topics which interact to inform our knowl-



Professor Anna C. Whittaker

edge of the mechanisms of lifestyle effects on healthy ageing and how to promote healthy ageing across a range of outcomes through lifestyle interventions. These topics encompass:

1. Assessment of data on ageing, extending from mid-adulthood to old age, on physical functioning, physical activity and nutrition, as well as effects on quality of life and mental abilities;
2. Studying the impact of sedentary behaviour on physical function and health in older adults, including testing an intervention to reduce sedentary time and improve outcomes post-surgery;
3. Testing the feasibility of seated resistance exercise interventions in very frail dependent older adults such as those in care homes or hospital, to see effects on physical function and health;
4. Developing a less-biased means of assessment of dietary intake and the factors influencing dietary choice in older adults from ethnic minorities;
5. Studying dysregulation of muscle mitochondrial function associated with ageing and various diseases via mathematical modelling of metabolism across different age groups and as a measure of different interventions within PANINI;

6. Understanding the impact of the Mediterranean diet on physical and psychological well-being and mental abilities including memory, attention and learning, as well as the speed of change in these parameters in ageing;

7. Investigating changes in sex steroids in ageing, particularly the menopause and their impact on muscle function, level of physical activity and psychological well-being;

8. Testing the impact of individually-tailored interventions which promote a pro-physical activity and social environment prior to and during periods of surgery in older adults to aid recuperation and slow progression to frailty;

9. Examining nutrition effects on muscle mass and function in older adults to understand the contributions of dietary intake and malnutrition on the decline of muscle function observed in ageing;

10. Discovering biomarkers of ageing, including inherited reversible changes in gene structure and function, called epigenetics, which can determine our biological ageing and health and testing if they also relate to physical function and;

11. Measuring the impact of genetic background on an individual's ageing and understanding how genetic background affects our nutritional choices and frailty risk.

## How will we learn more about ageing from the PANINI project?

A key target of PANINI is to develop next-generation researchers able to communicate healthy ageing research across disciplines, which is essential for 'whole person' physical activity and nutrition research. The key impact will

be through the widely disseminated advances in understanding the processes that contribute to healthy ageing and the factors and mechanisms underpinning successful interventions.

**"Although life expectancy is increasing by 2 years per decade, the period of life spent in good health (health span) is not keeping pace with lifespan."**

The key outputs will be a PANINI toolkit and shared dataset; public engagement activities and academic dissemination; and a health policy statement in collaboration with stakeholders including older adults themselves, ageing charities and policy makers.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No 675003.  
[www.birmingham.ac.uk/panini](http://www.birmingham.ac.uk/panini)



**Professor Anna C. Whittaker**  
**Professor of Behavioural Medicine**  
 School of Sport, Exercise & Rehabilitation  
 Sciences, University of Birmingham  
 Tel: +44 (0)121 414 4398  
[a.c.whittaker@bham.ac.uk](mailto:a.c.whittaker@bham.ac.uk)  
[www.birmingham.ac.uk/panini](http://www.birmingham.ac.uk/panini)  
[www.birmingham.ac.uk/staff/profiles/sportex/phillips-anna.aspx](http://www.birmingham.ac.uk/staff/profiles/sportex/phillips-anna.aspx)  
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# Good management is essential for positive mental health in the workplace

Mental Health Europe's Director Maria Nyman shares insights on how to promote a positive work environment to improve workplace mental health

**T**he benefits of promoting positive workplace mental health, as well as the existing psychosocial risks linked to work and employment, are widely acknowledged. Most of us will also know from our own experience the important place that work takes in our lives and how it impacts our mental health and well-being – for better or worse.

What is a psychosocial risk in the workplace? Put simply, it is an occupational hazard that affects the psychological well-being of workers. In Europe, the main psychosocial risks factors in the workplace include heavy or unmanageable workload, unrealistic expectations, role ambiguity, organisational changes, low job satisfaction and personal accomplishment, lack of recognition, poor work-life balance, interpersonal relations and support at work and workplace violence, including harassment and bullying. When one or many of these factors become part of our everyday lives they can lead to stress, anxiety, depression, burn-out, somatic health issues or even, in severe cases that go unaddressed, suicide.

Despite this, there is still poor recognition of the importance of good management for mental health in most workplaces across Europe and many employers and employees lack knowledge and awareness on how to create mentally healthy workplaces and how to address and minimise the risks. This is why mental ill health has become one of the leading causes of absenteeism from work and early retirement all over Europe. On top of this, getting back to work after a period of mental ill health is often a challenge due to lack of support. This can lead to a negative spiral for mental health and leads to long-term unemployment and exclusion from the labour market.



*Maria Nyman, Director*

We spend a lot of our time and lives at work and if we are not satisfied, feel overwhelmed or lack support or recognition this will have a major impact on our overall health.

Work-related stress is the second most reported health problem in the workplace in Europe. The human and social costs that come with mental ill health are too important to be ignored. Moreover, the costs for employers and society in terms of absence from work and presenteeism (being less productive or effective at work due to mental ill health) are huge.

Our mental health is influenced by different social determinants including factors which are not always

related to work, however, there is a lot that can be done in the workplace. Creating mentally healthy workplaces starts with understanding and commitment at a senior level. Fostering mentally health working conditions begins with looking at how the culture of the workplace and work organisation impact on the wellbeing of all employees.

Research has shown that even the simplest mental health promotion programmes are cost-effective in improving the mental health and productivity of workplaces. Managers have a key role to play here in supporting an organisational culture that promotes positive mental health. Having a good manager can help employees to better cope with work-related stress or mental ill health and there are good training programmes available that can equip managers with the skills and confidence they need to support people showing signs of distress.

### **So, what can and should be done?**

The most important but also difficult challenge is the stigma surrounding mental health in society. Stigma leads to discrimination and negative attitudes. Self-stigma is very common as well, preventing people from seeking help or speaking openly about the difficulties they face. Although fighting stigma will require awareness-raising throughout society, managers can contribute by creating a culture of openness about mental health, which should not be a taboo but a normal topic for conversation, since mental health affects everyone, employers as well as employees.

For this to happen there is a need for support and commitment at board level. The organisational structures within workplaces also play a crucial role in the wellbeing of employees since they lie at the heart of communication and leadership. Simple adjustments allowing employees more control over the way work is done can be good for productivity and the mental health of everyone.

I would like us to come to a point where we can talk as openly about our mental health as we do about our physical health and where mental health is a

cornerstone of any public health initiative. We need a European-wide anti-stigma campaign supported by the European Union and its member states. We need information about mental health at work which is accessible to all employees and employers, so they know where to go if they need help and support. Training of front-line managers and scaling up of promising practices in the field would be a good place to start.

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**“Work-related stress is the second most reported health problem in the workplace in Europe. The human and social costs that come with mental ill health are too important to be ignored. Moreover, the costs for employers and society in terms of absence from work and presenteeism (being less productive or effective at work due to mental ill health) are huge.”**

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Mental health at work should be everyone's concern: there is no “us and them” – because we all have mental health and it should be treated as an asset and protected in our workplaces.

Mental Health Europe is a European non-governmental network organisation committed to the promotion of positive mental health, the prevention of mental distress, the improvement of care, advocacy for social inclusion and the protection of the rights of (ex)users of mental health services, persons with psychosocial disabilities, their families and carers. ■

Find more about work on mental health at work at [www.mhe-sme.org](http://www.mhe-sme.org)

### **Maria Nyman**

#### **Director**

Mental Health Europe

[info@mhe-sme.org](mailto:info@mhe-sme.org)

[www.mhe-sme.org](http://www.mhe-sme.org)

[www.twitter.com/MHESME](https://twitter.com/MHESME)

# From Rwanda into the clinical pharmacy in the Palatinate

As part of their partnership, Rhineland-Palatinate region of Germany and Rwanda foster the exchange of knowledge in hospital management, medical professions and psychiatric care by funding mutual visits of their local experts as this profile reveals

In the course of this exchange, two young scholarship holders visited Pfalzkrankenhaus, service provider for mental health: With a firm handshake and a warm smile John Wilson Niyigena was welcomed in Klingenstein. Starting at the beginning of September the 35-year old man from Rwanda gained experience as a scholarship holder in the clinical pharmacy of Pfalzkrankenhaus for four weeks.

John Wilson Niyigena had studied at universities in Rwanda and Kenya and holds a Master's degree in business administration. For more than seven years he has worked as a project manager in the Rwanda Biomedical Center. He was in Germany for the first time. "I would like to see how the distribution and purchase of drugs works here and I want to establish contacts with suppliers", the 35-year old man says. For the duration of his scholarship he lived in Bad Bergzabern. John Wilson Niyigena also gained insights into other Pfalzkrankenhaus locations. Amongst others, he took part in pharmaceutical inspections in the day centers in Rockenhausen and Kaiserslautern in the northwestern part of the Palatinate, in Germany. Additionally, the scholarship holder had the opportunity to get to know better his colleagues and the sights of the Palatinate during several excursions.



Image: © Janik Klemm

*Welcoming of Jean d'Amour Ruhigira (centre) by the management at the beginning of his scholarship*

After his four-week stay at Pfalzkrankenhaus, John Wilson Niyigena moved to Kaiserslautern where the scholarship holder was also employed in the clinical pharmacy of Westpfalz-Krankenhaus until the end of October 2017. In return, his colleague Jean d'Amour Ruhigira came to the clinical pharmacy in Klingenstein for some weeks. The 28-year old pharmacist has completed a Bachelor of Science programme in pharmacy in his home country Rwanda and wanted to extend his knowledge of logistics, marketing, client acquisition and pharmaceutical products.

For two years he worked as a pharmacist with the company Gilmed Rwanda

Ltd., in the capital Kigali. His experience with international partners in Belgium, India and Turkey proved to be as interesting for the clinical pharmacy, as a possible access to the Rwandan market for which Jean d'Amour Ruhigira had offered his support.

The young executive and his fellow countryman John Wilson Niyigena were in Germany for the first time. "Here, I would like to get to know a new way of working", Jean d'Amour Ruhigira explains. He gave an account of the different ways of working in the two countries. He reported that in Rwanda it was not usual practice to focus on one activity only. He illus-

Image: © Janik Klemm



*For the first time in Germany: Scholarship holder John Wilson Niyigena (on the left) during his work in the clinical pharmacy*

trated that in his home country a different way of working was practiced, and many activities took place side by side.

Here in Germany, he was fascinated by the fact that in the first instance, one task was worked on in a focused manner and only after its completion, the next task was started. Apart from his service in the pharmacy, the 28-year old man visited the Wine Festival in Neustadt together with colleagues from Pfalzkllinikum. The exchange programme is promoted by the state of Rhineland-Palatinate and the organisation icunet looked after the executives receiving a scholarship for their stay. Prior to their employment in enterprises, the experts from Rwanda had undergone via icunet a three-week cultural orientation in Germany.

## Knowledge exchange at an eye-level

Pfalzkllinikum has established good contacts with the partner country since 2016. It cooperates with Ndera Hospital in Kigali, the largest neuro-psychiatric provider. Delegations from the Palatinate and Rwanda paid visits to each other and exchanged their views on their respective fields of work.

For three years starting in 2017, Pfalzkllinikum has been a project partner of the Federal Ministry for Economic Cooperation in the project "500 clinic partnerships" supported by the Else Fresenius foundation. Its focus is on the establishment of community-based psychiatric structures and self-help as well as clinical work and the exchange of knowledge.



**Irina Kast**  
Deputy Director of Corporate Communications

**Janik Klemm**  
Trainee Corporate Communications  
Pfalzkllinikum AdöR  
[www.pfalzkllinikum.de](http://www.pfalzkllinikum.de)



# The provision of effective cross-border healthcare

Professor Ruth Ladenstein from SIOPE (the European Society for Paediatric Oncology) discusses how ERN PaedCan facilitates effective cross-border healthcare

The European Commission launched 24 different networks to bring together experts from across the EU to tackle rare diseases by improving diagnosis, treatment and access to specialist care. These are known as (European Reference Networks (ERNs).

## Childhood cancer

Paediatric cancer is per se a very rare disease that comes in multiple subtypes and represents both a life-threatening disease and a major public health issue. With 35,000 children and adolescents newly diagnosed with cancer across Europe and 6,000 young patients dying each year, it remains the leading cause of death from disease for children older than one year of age.

*“As Vytenis Andriukaitis (EU Commissioner for Health and Food Safety) has said, ‘no country alone has the knowledge and capacity to treat all rare and complex conditions’. Nonetheless, through cooperating and exchanging life-saving knowledge at European level, patients across the EU will be able to gain access to the best expertise available.”*

Average survival rates have improved in recent decades and although the progress has been dramatic for some conditions, the outcomes remain very poor for some others. Significant inequalities in survival rates are also a challenge in Europe, with worse outcomes in Eastern European countries.

## European Reference Network on Paediatric Cancer (ERN PaedCan)

The ERN PaedCan aims to make national health systems cooperate in the interest of patients. The goal is to reduce inequalities in childhood cancer survival by providing high-quality accessible and cost-effective cross-border healthcare to European children and

adolescents with cancer, regardless of where they live. This network currently unites 57 institutions from 18 European countries working together to help children and teenagers with cancer.

The ERN PaedCan implements eHealth technologies and facilitates cross-border consultations (e.g. via the Clinical Patient Management System (CPMS) provided by the EC), to share expertise in rare conditions and give cross-border advice.

To make specialised knowledge and life-saving paediatric oncology treatments broadly accessible, the ERN PaedCan creates a roadmap of pan-European healthcare centres that are renowned for their expertise in treating paediatric malignancies. This network facilitates the lives of both healthcare providers and of patients, whose conditions require specialist expertise and tools not widely available, due to low case volumes and a lack of resources.

Finally, yet importantly, this network helps young patients and their families in making informed choices by providing clear information regarding access, quality, safety and reimbursement for treatments received in another EU country. All this represents more treatment options and less red tape for young patients and their families.

## Cross-border healthcare

Cancer is a life-threatening disease, and there is still a long way to go to overcome inequalities and ensure safer and good quality treatment across EU borders. The need to improve access to standard care across Europe and to increase the cure rates for all paediatric cancer types should be a priority for all those who care for childhood cancer patients and survivors.



As Vytenis Andriukaitis (EU Commissioner for Health and Food Safety) has said, 'no country alone has the knowledge and capacity to treat all rare and complex conditions'. Nonetheless, through cooperating and exchanging life-saving knowledge at European level, patients across the EU will be able to gain access to the best expertise available. This network offers a platform for the development of guidelines, training and knowledge sharing. There is no doubt that cross-border healthcare will unite specialists across Europe to tackle complex or rare cancer conditions that require highly specialised interventions and a concentration of knowledge and resources.

The ERN PaedCan will increase childhood cancer survival and quality of life in the long-term by fostering cooperation, research and training, with the ultimate goal of reducing current inequalities in childhood cancer survival and healthcare capabilities in EU Member States. It enables access to data diagnostics and treatments by facilitating the exchange of knowledge and expertise, allowing information to travel

rather than the patients through the implementation of a Virtual Consultation System.

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**"Average survival rates have improved in recent decades and although the progress has been dramatic for some conditions, the outcomes remain very poor for some others."**

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The hope is that ERN PaedCan will provide concrete results for many patients so that they are no longer looking for answers in the dark but instead can benefit from the best knowledge available in Europe, so they may lead healthier and longer lives. ■

**Professor Ruth Ladenstein**

**Coordinator for ERN PaedCan and a SIOPE board member**

SIOPE (the European Society for Paediatric Oncology)

Tel: +32 2 775 02 12

[office@siope.eu](mailto:office@siope.eu)

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

[www.twitter.com/siopeurope](https://www.twitter.com/siopeurope)

# Paediatric sarcoma metastasis: An area that warrants in-depth exploration

Ivan Stamenkovic, Professor of Experimental Pathology at University of Lausanne explores the paediatric sarcoma metastasis and why this warrants an in-depth look at

**M**etastasis is responsible for 90% of cancer-related death. Several solid paediatric malignancies, particularly sarcomas, display high metastatic proclivity, which renders their prognosis poor, as metastases are for the most part unresponsive to conventional chemotherapy, even if the primary tumour is sensitive. Most of our understanding of the multistep process that constitutes metastasis comes from studies on carcinomas, which, at least in part, mimic the sarcoma phenotype to metastasize.

Most disseminating carcinoma cells undergo epithelial-to-mesenchymal transition (EMT), a reversible process by which they transiently adopt a variable mesenchymal phenotype. EMT appears to be critical for carcinoma cell motility, as epithelial cells are largely non-motile, as well as invasion and possibly other steps leading up to secondary colony formation. Once they have reached their final destination, disseminated carcinoma cells revert to their epithelial phenotype to grow and form metastatic tumours. Being of mesenchymal origin, sarcoma cells are naturally motile and may already possess all the properties necessary for dissemination.

They, therefore, do not need to undergo any phenotypic change and provide ideal cells to study metastasis and determine how metastatic lesions may differ from the corresponding

primary tumours. Extensive genomic studies on carcinomas have shown convincingly that there are no metastasis-specific genetic mutations, indicating that cells with metastatic potential are already part of the primary tumour and that epigenetic modifications are most likely responsible for providing them with the properties necessary to complete all the steps required for metastatic tumour growth.

The same is likely to hold true for paediatric sarcomas, including Ewing sarcoma, alveolar rhabdomyosarcoma (ARMS), synovial sarcoma and desmoplastic small round cell tumour (DSRCT), all of which tend to metastasize early and with high frequency. However, given their mesenchymal origin and phenotype, it will be important to determine whether metastatic properties are confined to a subset of cells in any given sarcoma or whether they are a common feature of most cells.

An essential property of cancer cells is their plasticity. Thus, carcinoma cells may transition bi-directionally between an epithelial phenotype and EMT or between a stem cell phenotype with tumour initiating properties and a more differentiated phenotype that is not tumorigenic. A pro-metastatic phenotype may therefore not be stable, but rather may be acquired transiently depending on the micro-environmental stimuli to which

a tumour cell or subpopulation thereof is exposed at different stages of tumour progression.

Like carcinomas, sarcoma cells display plasticity and may transition in a dynamic manner from metastasis-competent to non-metastatic variants and vice-versa. This phenotypic instability renders therapy particularly challenging for several reasons. Firstly, it is necessary to define the epigenetic profile that is responsible for conferring metastatic properties and to develop therapeutic strategies that can target the relevant epigenetic modifiers or their effects in a way that can cause the cells to lose key properties required for metastasis.

Secondly, it is necessary to understand the mechanisms by which cells without metastatic properties can acquire or re-acquire them. Understanding tumour cell plasticity is at least one requisite in the quest to counter the ability of malignant tumours to metastasize.

A major focus of metastasis research in recent years has been the isolation and characterisation of circulating tumour cells (CTCs). Once again, circulating carcinoma cells have attracted the greatest attention and it has been demonstrated that CTCs display variable EMT and CTC clusters are more effective in generating metastases than isolated CTCs. Very little work has been done on paediatric sarcoma



*Spine metastasis: MRI of thoracic and lumbar spine*

CTCs, but it will be of interest to determine to what degree sarcoma CTCs differ from bulk tumour cells, whether they require adaptation to sheer stress and whether they are enriched in cancer stem cells.

The relevance of tumour plasticity has been underscored by studies on the CTC phenotype in response to therapy. CTCs from different types of carcinoma have been observed to display increased EMT in response to chemotherapy, suggesting that EMT may confer at least partial resistance to therapy. Much less work has been done on paediatric tumour CTCs and it will obviously be of major importance to determine how such CTCs adjust their phenotype in response to therapy.

Moreover, CTCs may further modify their phenotype once they penetrate a secondary tissue, such that the phenotype observed in the circulation may undergo substantial changes as the cells adapt to the newly colonised tissue in which they must survive and divide. This continued dynamic phenotypic adjustment constitutes a major challenge to precisely identifying the epigenetic changes that are responsible for endowing tumour cells with metastatic properties.

One of our primary goals is to elucidate the epigenetic mechanisms that underlie paediatric sarcoma plasticity and to develop therapeutic approaches that could counteract their effects and possibly redirect the epigenetic changes

themselves to generate cells that lack the ability to disseminate and initiate tumour growth.



**Ivan Stamenkovic**  
**Professor of Pathology, Director**  
**Experimental Pathology Service**  
 Centre Hospitalier Universitaire Vaudois  
 (CHUV) University of Lausanne  
 Tel: +41 21 314 7136  
 Ivan.Stamenkovic@chuv.ch



# Drug development for cancer and inflammatory disease

Sumith A Kularatne, Vice President of Research and Development at On Target Laboratories shares the research strides he has made in drug development

**"M**en are haunted by the vastness of eternity. And so we ask ourselves: will our actions echo across the centuries? Will strangers hear our names long after we are gone and wonder who we were, how bravely we fought, how fiercely we loved?" – Odysseus (Troy).

Sumith A. Kularatne, Ph.D., is the Vice President of Research & Development at, On Target Laboratories, LLC (OTL), West Lafayette, IN (March 2012 – present). Dr. Kularatne is a world-class researcher and problem solver within the field of drug design and development for cancer and inflammatory disease. In fact, his distinctive and unparalleled approach to solve the problems associated with the diagnosis and treatment of cancer has been nothing short of unique and groundbreaking.

Dr. Kularatne says that "health holds a very important role in one's life, as President Thomas Jefferson said. Liberty is to the collective body, what health is to every individual body... Without health no pleasure can be tasted by man... without liberty, no happiness can be enjoyed by society".

Therefore, Dr. Kularatne uses his diverse set of skills, ranging from medicinal chemistry, organic chemistry, cancer biology, biochemistry, molecular biology, protein and antibody engineering, and animal model development for drug testing that



enables him to solve problems from a multidisciplinary approach and to discover better therapies with higher efficacy. Throughout his research career, Dr. Kularatne has been dedicated to developing targeted-imaging agents, diagnostic methods, and – therapeutic agents for cancers such as prostate, ovarian, lung, breast, and leukaemia and their metastatic disease and inflammatory diseases, such as rheumatoid arthritis and heart disease.

## Research strides

Under his guidance, OTL has developed a strong pipeline for several types of cancer and inflammatory diseases. OTL38, a folate receptor (FR)-targeted near infrared (NIR) dye, has been proven safe in a phase I trial and effective in a completed phase II

clinical trial for ovarian cancer. A phase II trial for lung cancer and a phase III trial for ovarian cancer began in summer 2017. The same NIR dye has been conjugated to additional ligands targeting receptors on prostate (OTL78: PSMA-targeted NIR agent), colon (OTL338: CA-IX-targeted NIR agent), and pancreatic (OTL81: CCK2R-Targeted NIR agent) cancers. These ligands can also be conjugated to a photodynamic therapeutic (PDT) agent, giving surgeons the option to visualize and 'burn' targeted lesions using the same light source and camera. A lead folate- PDT compound (OTL228) has been identified with others to follow.

He pursued his postdoctoral studies in molecular biology and biomedicines with Peter G. Schultz, CEO and Professor of Chemistry at The Scripps

Research Institute (TSRI), San Diego, CA (Dec 2009-Feb 2012). Dr. Schultz was the founder and former director of GNF, and is the founding director of the California Institute for Biomedical Research (Calibr) La Jolla, CA. Dr. Kularatne's projects at TSRI focused on selective diminishing of primary tumor masses, metastatic cancers, and cancer stem cells using antibody drug conjugates (ADCs) or using bispecific antibodies (antibody-dependent cell-mediated cytotoxicity or ADCC).

**“Innovation is a process that starts from coming up with a new idea to launching a new product in the market.” Dr Sumith A Kularatne.**

Dr. Kularatne earned his Ph.D. in organic/medicinal chemistry from Purdue University, West Lafayette, IN (Dec 2005-Dec 2009), conducting research under the guidance of Philip S. Low, the Ralph C. Corley Distinguished Professor of Chemistry and Director of the Purdue Center for Drug Discovery at Purdue University. Dr. Low is also the co-founder and CSO of both Endocyte and On Target Laboratories. Dr. Kularatne's research at Purdue University concentrated on small molecule-targeted drugs for cancers and inflammatory diseases.

His scientific efforts have resulted in 6 drug candidate in human clinical trials with multiple companies, over 50 US and foreign issued/pending patents and over 30 peer-reviewed publications. He has given multiple invited seminars/lectures in prestigious conferences such as “Gordon Research Conference” on “Drug Carriers in Medicine & Biology”, as well as in national and international conferences, universities, and industries. Dr. Kularatne's scientific involvements have also led to several international

and national awards including, “SBIR Phase II Grant Award for Non-Small Cell Lung Cancer Research (2017)”, “Distinguished Partners in Hope Award for OTL for fueling innovation, and providing hope to lung cancer patients (2016)”, “Innovation Corps at NIH program for SBIR Award for Drug Development for Non-Small Cell Lung Cancer (2016)”, “SBIR Phase I Grant Award for Non-Small Cell Lung Cancer Research (2014)”, “AAPS Postdoctoral Fellow Award sponsored by Merck (2012) for CXCR4-targeted antibody drug conjugates for metastatic cancers”, “the Skaggs Postdoctoral Fellow Award (2010)”, “AAPS Graduate Student Award in Biotechnology, sponsored by Pfizer (2009) for PSMA-targeted drugs for prostate cancer, AAPS Graduate Student Symposium sponsored by Eli Lilly (2009) for PSMA-targeted drugs for prostate cancer, Delano Maggard, Jr. graduate research award (2005)”, ACS recognition Chemist of the year (2004), E. A. Talaty fellowship (2003) and the B. L. Paker Endowed fellowship (2002). He is an invited member of multiple honorary societies including Phi Kappa Phi (NSF), National Society of Collegiate Scholars, and Beta Phi Upsilon. He is also an invited peer reviewer for multiple scientific journals including Journal of Organic Chemistry, Molecular Pharmaceutics, Journal of Medical Case Reports, Nature Publishing group, and Drug Delivery.

Looking back on his 11 year career, Dr. Kularatne said that “I am fortunate and blessed to develop drugs that can possibly make a tremendous impact on human life, especially those who are suffering from cancer and their loved one”. He believes what Michael Jordan said “talent wins games, but teamwork and intelligence wins championships”. Dr. Kularatne stated that “I want to



emphasis that all the accomplishments I have been involved with were a team effort. I have always been around a great group of people committed to work in cohesion with one another. I have been guided by great leaders and mentors. I have great parents, family and friends who support me unconditionally. So, I feel I was prepared by mentors and family to accomplish great things as mentioned by Sun Tzu, The Art of War, 400 B.C. “Every battle is won before it is fought”.

**ON + TARGET**  
LABORATORIES

**Sumith A Kularatne PhD**  
**VP of R&D**

On Target Laboratories, LLC  
1281 Win Hentschel Blvd  
West Lafayette IN 47906  
Tel: +1 765 588 4547  
skularatne@ontargetlabs.com  
www.researchgate.net/profile/  
Sumith\_Kularatne  
<http://bit.ly/1Q4Ji8V>  
<https://twitter.com/SumithKularatne>  
<http://bit.ly/GooglePlusSumith>  
<http://bit.ly/FacebookSumith>

# The challenge of sustainability in cancer care

All.Can shares their profound insights into the challenges concerning the need to improve the efficiency of cancer care, focusing on better outcomes for patients

**H**ealthcare budgets are under increasing pressure. We face an urgent question about how we can sustain high-quality healthcare.

All.Can is an international multi-stakeholder initiative set up to tackle the challenge of sustainability in cancer care, by addressing one of the main obstacles – the pervasive waste and inefficiency of care systems.

Our approach is simple: focus only on what matters most to patients. There are countless data showing that ignoring patient needs results in inefficient practices, including delays; poor communication; inappropriate, fragmented and duplicated care; insufficient follow-up; negative impact on quality of care and quality of life; and a general disconnect between patient needs and care given.

The World Health Organisation (WHO) estimates that 20% of spending across all healthcare systems is wasted.<sup>1</sup> As cancer is a key component of healthcare and one of the main drivers of expenditure, it is here we can begin to address this urgent problem. And the results can be transformative – the OECD also predicts that countries could gain approximately 2 years' life expectancy by reducing inefficiencies across healthcare systems.<sup>2</sup> Two years – just through better allocation of resources.

Focusing on patient needs will lead to a better yield from resources used, an improved quality of care for patients and less waste. Our 2017 policy<sup>3</sup> report highlights numerous examples where simple changes, based on observations of patient needs, have had a dramatic impact on costs, waiting times, healthcare professional time, patient satisfaction, stress and anxiety. One manufacturer of imaging tests, for example, noticed that paediatric patients were so nervous before their MRI scan that over three-quarters of them needed

to be sedated or to have their scans rescheduled if an anesthesiologist was not available.

But by decorating the intimidating MRI scanners with fun themes like a pirate ship or space rocket, they turned a scary and unfamiliar process into an adventure. The number of children needing sedation dropped, meaning more could be scanned per day and overall patient satisfaction scores went up by 90%.<sup>4</sup> This is an individual example, but one that could be rolled out globally, with minimal cost, potentially leading to dramatic improvements in patient outcomes.

“People need to go back to the primary source, which is the patients. These are the people at the coalface of their diseases; these are the people who can provide the answers” said Kathy Oliver (Chair and founding co-director of the International Brain Tumour Alliance and All.Can member).

This is not simply an academic exercise. All.Can is using patient insights to inform compelling evidence that can drive real policy change. We are aiming to create practical, targeted policy recommendations for individual countries, that ensure cancer policy is focused on meaningful outcomes for patients above all other considerations, thereby removing unnecessary, problematic or obsolete practices and processes.

We are working in partnership with leading organisations such as Quality Health, the International Consortium on Health Outcomes Measurement (ICHOM) and the European CanCer Organisation (ECCO) on four different research projects, to understand where patient care could be improved and how existing inefficiencies can be identified and removed. The aim is to standardise and share efficient and patient-focused practices across all aspects of cancer care.



Finally, All.Can strongly believe that reducing inefficiencies cannot be a simple cost-containment exercise. Focusing only on cutting costs without consideration to patient outcomes may negatively impact the quality of care and undermine long-term sustainability for short-term gain.

Solutions to these problems will invariably involve change, which may at times prove uncomfortable, difficult and even counter-intuitive. Decisions over the removal of certain processes are always difficult, but inefficient, obsolete and unnecessary processes must be removed. The consideration around what to remove and what to keep should come down to one thing and one thing only: whether it positively contributes to patient outcomes.

This is why we need all stakeholders involved in the discussion, to create the trust that we're all headed in the same direction, improving patient outcomes and ensuring the sustainability of cancer care. We all have a responsibility and a vested interest, in improving the efficiency of cancer care. Join us, work with us, together #WeAllCan. ■

*All.Can is a multi-stakeholder initiative involving patient, clinical, academic and industry experts as well as policymakers. We aim to help define better solutions for sustainable cancer care and improve patient outcomes in the future. The All.Can initiative is made possible with financial support from Bristol-Myers Squibb (lead sponsor), Amgen, MSD and Johnson & Johnson (co-sponsors).*

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#### All.Can

secretariat@all-can.org

[www.all-can.org](http://www.all-can.org)

[www.twitter.com/AllCanGroup](https://twitter.com/AllCanGroup)



# The global burden of cancer in young adults

Dr Miranda Fidler from the International Agency for Research on Cancer highlights the burden of cancer and the need for prevention, diagnosis, and care

Cancer is a major cause of morbidity and mortality across all age groups in both developed and transitioning countries. Although substantial research on cancer in children and older age groups has been undertaken, the burden of cancer among young adults (20-39 years) has rarely been studied in depth, often being overlooked by cancer researchers and policymakers alike. With an increasing need of international research investigating the specific issues unique to this age group of cancer patients to improve cancer-related outcomes, a recent report sought to assess the scale and profile of young adult cancers globally<sup>1</sup>.

## Analysis

Although it is broadly accepted that the age range for childhood and adolescent cancer is 0-14 and 15-19 years, respectively, the age range for young adult oncology is less clear as there is no uniform opinion on the upper age limit for this group. In the study by Fidler et al, young adult cancers were defined as those that occur between the ages of 20 and 39 years, which is in line with that suggested by the Adolescent and Young Adult Oncology Progress Review Group.

Using the International Agency for Research on Cancer (IARC)'s GLOBOCAN database, the study authors estimated the number of new cancer cases and cancer-related deaths for all cancers combined (excluding non-melanoma skin cancer), as well as by 27 specific cancer sites. Variations in the cancer burden among young adults were assessed at the country and regional level, as well as by the Human Development Index (HDI), which uses life expectancy, education and gross national income to give an indication of socioeconomic development.

## Global burden and cancer profile

In total, an estimated 975,000 new cancer cases and



358,000 cancer-related deaths occurred among young adults globally in 2012. Of these, 65% of all new cancer cases and 54% of cancer-related deaths occurred in women.

The cancer profile among young adults was observed to bridge between pediatric and adult oncology. Common tumour types in children and adolescents, including leukaemia and cancers of the brain/nervous system were among the higher-ranking cancers at ages 20-39. However, common epithelial tumours such as breast, cervical, and colorectal cancer were more frequently observed among young adults than children or adolescents, though still to a lesser extent than that observed in older ages.

Breast or cervical cancer was the most common cancer type in young adults for most countries in terms of incidence and mortality and together accounted for about

302,000 (31%) of the total estimated new cases and about 77,000 (21%) of the total estimated cancer-related deaths. Other frequently diagnosed cancers included thyroid cancer, leukaemia, and colorectal cancer. In terms of deaths, leukaemia, liver cancer, and brain/nervous system tumours were large contributors to the burden in addition to breast and cervical cancer.

### Global variations

Variations in the cancer burden among young adults were evident when the data were stratified by the HDI. Breast and cervical cancer were ranked the first and second most common cancers, respectively, in the low, medium, and high HDI levels, whilst at the very high HDI level these cancers ranked first and fifth, respectively. In general, cancers associated with infection, such as liver cancer and Kaposi sarcoma, were more frequent in countries indexed within the low HDI level, whilst thyroid cancer, skin melanoma, and testicular cancer were highly frequent in very high HDI regions.

Such differences in the distribution of cancer types, with more fatal cancers generally more prominent in low HDI settings, was in turn partially responsible for the poorer cancer outcomes noted among young adults from these regions. Fractured health infrastructures, the detection of cancers at a later stage and poor access and availability of treatment also likely relate to the worse outcomes in less developed regions.

### Moving forward

With nearly one million cancers occurring among young adults worldwide in 2012, efforts are urgently needed to address the cancer burden in this age group. Particular opportunities for improvement relate to:

- Cancer prevention;
- Early detection and timely diagnosis;
- Access to appropriate and affordable treatment and;
- Expanding the young adult cancer agenda beyond high-income countries.

For example, given the particularly heavy burden of breast and cervical cancers, increasing awareness of

cancer in young women at both the public and professional levels as well as timely treatment is of key importance. National human papillomavirus (HPV) vaccination programs, early detection, and, in women older than 30 years, screening, could significantly reduce the global burden of cervical cancer in young women, at a limited cost.

In closing, although cancer is less frequent in young adults than at older ages, its impact remains considerable because these individuals have a large proportion of their expected lifespans remaining, contribute substantially to the economy, and play an important role in caring for their families.

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**“In total, an estimated 975,000 new cancer cases and 358,000 cancer-related deaths occurred among young adults globally in 2012. Of these, 65% of all new cancer cases and 54% of cancer-related deaths occurred in women.”**

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As young adult cancer patients exhibit a combination of features observed in younger and older patients, it is crucial that progress is achieved through a combination of the methods that led to improvements in these other groups: advancement of risk stratification and treatment protocols through clinical trials in children and implementation of effective prevention and early detection at older ages. ■

1 Fidler MM, Gupta S, Soerjomataram I, et al. Cancer incidence and mortality among young adults aged 20-39 years worldwide in 2012: a population-based study. *Lancet Oncol* Published Online First: 28 November 2017. doi:10.1016/S1470-2045(17)30677-0

### Dr Miranda Fidler

#### Postdoctoral fellow at IARC

International Agency for Research on Cancer

World Health Organization

Tel: +33 (0)4 72 73 84 85

fidlerm@fellows.iarc.fr

www.iarc.fr

www.twitter.com/iarcwho

# Lymphoma – what’s that?

Experts from the Lymphoma Association offer their thoughts on the extent of lymphoma in the UK today and how treatment and diagnosis can improve

Every 28 minutes someone is diagnosed with lymphoma. It is the fifth most common cancer in the UK with more than 19,000 people diagnosed every year, including diagnoses of chronic lymphocytic leukaemia (CLL), which is a form of lymphoma despite its name.

As the most common haematological or blood cancer, the latest data shows that around 125,000 people are currently living with lymphoma or CLL. Furthermore, while being a cancer that generally presents itself in older age, it is also the most common cancer in teenagers and young adults aged under 30. Despite these statistics, lymphoma is neither well known nor easily understood.

**“At a time when politicians debate the direction of the NHS and the provision of cancer services, we hope to see more attention given to cancers outside of the ‘top four’ (breast, bowel, lung, and prostate).”**

Lymphoma is a complex disease with two main categories: Hodgkin lymphoma (HL) and non-Hodgkin lymphoma (NHL), the latter of which also has a great number of subtypes. Outcomes vary according to subtype, stage of diagnosis, treatment and patient age. While lymphoma shares some similarities with other types of cancer, there are important aspects where it differs and that give a distinct slant to the Lymphoma Association’s work in supporting people affected by a diagnosis.

For most cases of lymphoma, there is no known cause. Therefore, public health promotion messages will have little impact. In this sense, it is a great “unknown” and “unknowable” disease. Lymphoma concerns a part of the body that few people know or understand – the

lymphatic system. As such, it can affect any part of the body. This makes it even harder to cope with and explain to other people.

Lymphoma can be incredibly difficult to diagnose. The main signs and symptoms of lymphoma – persistent lumps, itching, tiredness, unexplained weight loss, and night sweats – are often attributed to other conditions. It’s essential that there is more awareness of lymphoma not only among the general public but also among GPs and primary care health professionals.

## Lymphoma types

For some forms of lymphoma, particularly indolent or low-grade forms, the initial treatment will be “no treatment”, in the form of “watch and wait”, whereby people with a diagnosis, but no troublesome symptoms, will see their specialist for regular check-ups and only begin treatment if problematic symptoms develop. This runs counter to mainstream cancer messaging which concentrates on spotting and understanding the signs and symptoms of cancer, leading to earlier diagnosis and speedy treatment, with, in many cases, a direct link to vastly improved outcomes.

Many forms of lymphoma are chronic cancers – while the majority of other cancers, particularly solid tumour ones, will be treated with curative intent, many forms of lymphoma are not curable, but they are eminently manageable as long-term diseases. As such, many people will live with lymphoma for a long time, with a number of relapses. It may well be that they outlive their cancer, but die from some other cause. This presents a whole range of additional issues for lymphoma patients and their families, including those around psychological support for coping with a long-term incurable cancer and a different approach to survivorship support.



In contrast, some forms of lymphoma are aggressive and if not treated quickly and effectively, will become terminal. Yet, at the same time, many of these aggressive forms are the ones that can be treated most successfully and have the potential to be cured. All this adds further to the complexity and difficulty in understanding lymphoma as a disease and cancer.

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**“Lymphoma is a complex disease with two main categories: Hodgkin lymphoma (HL) and non-Hodgkin lymphoma (NHL), the latter of which also has a great number of subtypes. Outcomes vary according to subtype, stage of diagnosis, treatment and patient age.”**

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It is all these differences that mean people affected by lymphoma will often come to the Lymphoma Association for disease-specific information and support. Many people will not have heard of lymphoma before their diagnosis, let alone know it is a form of cancer. Furthermore, for people living with a particularly rare form of the disease, the only way they will come across another person affected by the same diagnosis is through one of the Lymphoma Association's support services.

At a time when politicians debate the direction of the NHS and the provision of cancer services, we hope to see more attention given to cancers outside of the 'top four' (breast, bowel, lung, and prostate). It's only through improved practices for diagnosing, treating, and supporting lymphoma patients and their families, that we will see better outcomes and improved patient experience for the thousands of people affected by a lymphoma diagnosis. ■

The Lymphoma Association  
Tel: +44 (0)1296 619 400  
[enquiries@lymphomas.org.uk](mailto:enquiries@lymphomas.org.uk)  
[www.lymphomas.org.uk](http://www.lymphomas.org.uk)  
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# RELEVANCE of red blood cells and why do we care about them

Anna Bogdanova from University of Zurich lifts the lid on the vital role of red blood cells in keeping the human brain running and heart beating

**B**illions of red blood cells run in our veins providing us with oxygen. They keep our brain running, heart beating and muscles bringing us wherever we want. Keeping these tiny cells filled with red cell oxygen carrier hemoglobin happy and healthy is vitally important.

“Thin blood” with low red blood cell counts, a condition known as anaemia, is a global burden that can be life-threatening. According to the World Health Organization, 1.62 billion people on our planet (or 1 in 4 people) are suffering from anaemia. 47.5% of all pre-school children are anaemic.

The large scope of patients and the scale of health problems they face turns fighting anaemia from solely a medical problem to a global socio-political economic challenge. Malnutrition and the treatment of iron deficiency led to improved anaemic patients results. However, this is not a viable solution for anaemia patients with hereditary conditions. In patients with “rare” anaemias v mutations in genome result in the production of abnormal hemoglobin, changes in cell membrane architecture and pathologies – related to the inability to maintain energy balance or resist oxidative stress. Hereditary hemoglobin instability in red cells of hundreds of thousands of children born with sickle cell disease in African countries takes the lives of approximately half of them before reaching five years of age.

Living with such severe disorders as sickle cell disease or thalassemia means pain, disability and a need for regular blood transfusions from a young age. Many patients with more “exotic” rare red cell diseases remain undiagnosed or maltreated around the globe. We often can determine the genetic basis of a disease, but this does not imply a cure exists. No gene editing medication is available in clinics to treat red blood cell disorders or any other disease.

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**“RELEVANCE is an Innovative Training Network that educates 15 early stage researchers from all over the world preparing them for future multidisciplinary careers in science, translational medicine and/or industry.”**

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So, we are left to struggle with the symptoms by transfusing stored blood, managing pain and coping with stroke, lung and liver problems and multiple organ failures as best as we possibly can. Therefore, we need a viable solution and hence this project, RELEVANCE (Regulation of red cell lifespan, erythropoiesis, survival, senescence and clearance) Consortium.

The successful treatment of red blood cell diseases is impossible without a deep understanding of the biological processes that control red cell production, ageing and destruction. So far, we still cannot harness and control these processes pharmacologically or by the development of preventive

lifestyle programmes to cure all these billions of patients with anaemia. The ability to engage the hidden forces our red blood cells to adapt to stress is a key to the final solution.

The challenges of the 21st century within the red blood cell research field include:

- Fighting all forms of anaemia;
- Development of new drugs and therapeutic approaches for treatment of not-so “rare” anaemias that can be afforded by African countries, thus, greatly improving the quality of life of these patients;
- Development of new devices and new tests so that researchers/clinicians can perform simple diagnosis and monitor severity of rare anaemias;
- Generating more red blood cells outside the body that may be used for transfusion (preferably patients’ own blood);
- Learning more about the ways red blood cells respond to stress and how to use organism’s natural defenses to fight against disease;
- Achieve better performance in sports athletes.

These problems may only be solved by joint efforts of clinical hematologists, blood banking experts, researchers



and industrial engineers. This type of novel approach must be done to drive the research forward. This demand and challenge is being met by several EU-scale consortia, RELEVANCE being one of them.

RELEVANCE (Regulation of red cell life-span, erythropoiesis, survival, senescence and clearance) Consortium is powered by the EU funding within the Marie Skłodowska-Curie Actions Program. Our research team is comprised of members in a diverse set of fields ranging from biophysics to physiology to biochemistry and genetics. Collaboration involves both clinical and industrial partners based in Germany, France, UK, Italy, Switzerland, Spain, the Netherlands and Denmark.

RELEVANCE has international and global implications with respect to red blood cell research, personalised medicine and sports medicine. Consortium partners are discovering new information on the fundamental mechanisms controlling red blood cell

turnover, structure and function in healthy vs anaemic patients. Initial findings led to the development of new technologies based on single cell analysis, imaging and microfluidic and laser technologies. They can be implemented to study red blood cell selection, investigating properties of red blood cells and faster and more accurate clinical diagnosis and evaluation of anaemic patients. We expect that the personalised medicine field to expand greatly based on the RELEVANCE work. Blood is in all of us and without it, we would cease to exist.

RELEVANCE is an Innovative Training Network that educates 15 early stage researchers from all over the world preparing them for future multidisciplinary careers in science, translational medicine and/or industry. By joining the network, the trainees get a unique opportunity to participate in all kinds of research activities and development of new industrial prototypes together with scientists and clinicians. During the coming months, we shall be

sharing with you our exciting findings, achievements and adventures in the world of red blood cells.



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 675115 – RELEVANCE – H2020-MSCA-ITN-2015/H2020-MSCA-ITN-2015.



**Professor Anna Bogdanova**  
**Head of Red Blood Cell Research Group**  
 University of Zurich  
 Tel: +41 44 635 8811  
[annab@access.uzh.ch](mailto:annab@access.uzh.ch)  
<http://relevance.arivis.com/>

# Pernicious Anaemia: The world's forgotten disease

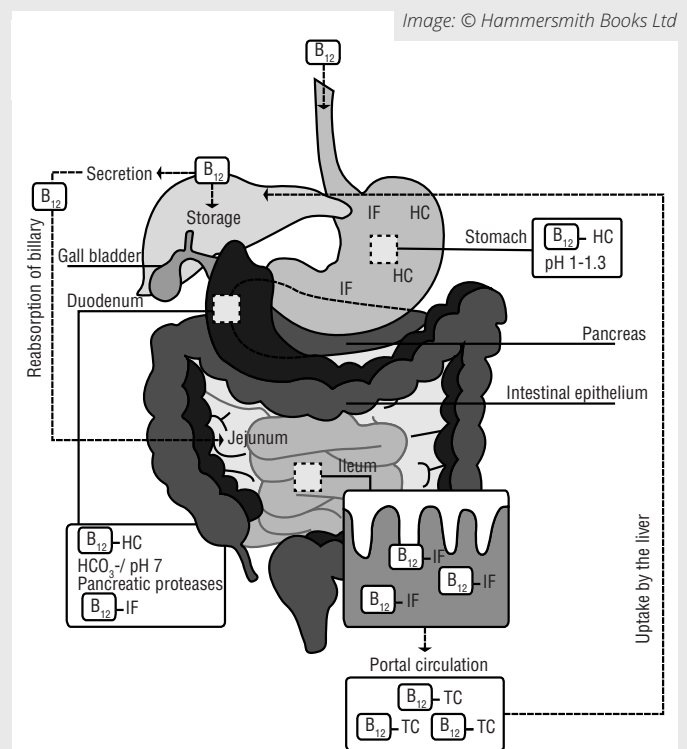
Chairman of The Pernicious Anaemia Society, Martyn Hooper MBE lifts the lid on the history, causes and diagnosis of the world's forgotten disease

From the time it was first described in the mid-nineteenth century, the cause and treatment of Pernicious Anaemia became the subject of some of the most inquisitive minds in medicine. From the mid-1920's the disease was treatable which, in most cases, meant that it was no longer a fatal condition and over the ensuing decades' treatment improved.

By the early 1960's, when the chemical structure of Vitamin B<sub>12</sub> was described by the author of the fourth Nobel Prize for their work associated with the disease, it was generally assumed that the nature of the disease was fully understood, and it stopped attracting the attention of mainstream doctors and scientists; it was as if the whole topic had gone to sleep. However, in recent years, it has become obvious that there are serious issues concerning how the disease is diagnosed and treated and as such, Pernicious Anaemia seems to be waking up after a decades-long slumber.

Before we examine these problems in greater detail, it's worth examining the nature of the disease. Pernicious Anaemia causes Vitamin B<sub>12</sub> Deficiency. A normal, healthy individual will produce a protein in their stomach called 'Intrinsic Factor', or IF for short. The Intrinsic Factor, along with Hydrochloric Acid will have been produced by the Parietal Cells that line the fundus in the body of the stomach.

The Intrinsic Factor will bind to Vitamin B<sub>12</sub> from any animal-based food such as meat, dairy, fish or, surprisingly, seaweed that has been eaten and it enters the bloodstream in the final part of the digestive system – the Ileum. Obviously, people who don't eat any animal products are at risk of becoming deficient in B<sub>12</sub> which is why most vegetarians and vegans will take oral supplements of the vitamin to avoid any harm. Some



*The digestive system showing the uptake of vitamin B<sub>12</sub>. (IF = intrinsic factor; HC = haptocorrin; TC = transcobalamin.)*

people produce an antibody that 'kills off' the intrinsic factor, the Intrinsic Factor Antibody and therefore don't absorb B<sub>12</sub> from their diet. These people have Autoimmune Pernicious Anaemia.

## Other causes

There are other causes of Vitamin B<sub>12</sub> Deficiency including a vegan diet and the elderly who suffer from age-related gastric atrophy (they simply stop producing IF). Another obvious group at risk are those who have had their Ileum removed by surgery. Some medicines also interfere with B<sub>12</sub> including treatments for gout, the contraceptive pill, proton pump inhibitors and the recreational use of nitrous oxide. Most people will be

able to replenish any dwindling B<sub>12</sub> levels by eating a healthy mixed diet or taking an oral supplement. This is not so the unfortunate patients who have Pernicious Anaemia who have to rely on lifetime injections of Vitamin B<sub>12</sub> to keep them alive.

### Problems diagnosing B<sub>12</sub> deficiency

The diagnostic problems begin with the symptoms which are vague and often associated with many other diseases; and they are insidious, often developing gradually over many years.

Then there is the false belief among most doctors that patients who are deficient in B<sub>12</sub> will have abnormally large red blood cells, whereas only around 60-70% of patients will have any macrocytosis. And now things really get tricky. You see, there's no real consensus of what numerical value constitutes a deficiency or sub-clinical deficiency.

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**“Pernicious Anaemia causes Vitamin B<sub>12</sub> Deficiency. A normal, healthy individual will produce a protein in their stomach called ‘Intrinsic Factor’, or IF for short. The Intrinsic Factor, along with Hydrochloric Acid will have been produced by the Parietal Cells that line the fundus in the body of the stomach.”**

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Oh, and the currently used Serum B<sub>12</sub> test is itself not fit for purpose - new guidelines tell doctors that if there is discordance with the test result and the patient's symptoms ignore the test result and treat the patient because left untreated, B<sub>12</sub> deficiency causes serious and irreversible nerve damage.

### Diagnosing Pernicious Anaemia

But let's assume a patient is identified as having low B<sub>12</sub>. The next stage would be to establish whether the deficiency is caused by Pernicious Anaemia. Unfortunately, the test that was pretty accurate at identifying whether the patient had Pernicious Anaemia – the Schilling Test – was withdrawn from mainstream service 20 years ago. And the test that replaced it, the Competitive Binding Luminescence Assay, is next to useless at picking up on whether the patient produces the intrinsic factor antibody. New guidelines state that if the patient tests negative for the antibody he or she can have Negative Antibody Pernicious Anaemia.

### Treating Pernicious Anaemia

The second major problem is how patients are treated where a one-size-fits-all approach is taken. Some patients need much more frequent replacement therapy injections of B<sub>12</sub> than others but are regularly refused them. This leads to the debilitating symptoms of extreme tiredness, personality changes and brain fogs returning long before the next injection is due, causing problems in the workplace and with social life.

The cost of misdiagnosis and non-diagnosis over many years has yet to be fully explored, but it is certainly a major drain on health budgets. In a recent survey of members of the Pernicious Anaemia Society, 33% waited over five years for a diagnosis, whilst 14% waited over 10 years. It is time for the problems associated with this disease to be thoroughly investigated. It really has become the world's forgotten disease.

Martyn Hooper is the founder and current chairman of the Pernicious Anaemia Society and is the author of three books about the disease. In January 2017, he was made a Member of the Order of the British Empire (MBE) for his services to people with Pernicious Anaemia. ■



### Martyn Hooper MBE Chairman

The Pernicious Anaemia Society

Tel: +44 (0)1656 769717

[chair@pasoc.org.uk](mailto:chair@pasoc.org.uk)

<https://pernicious-anaemia-society.org/>

[www.twitter.com/PASOC](https://twitter.com/PASOC)



# Acute myeloid leukaemia (AML)

Acute myeloid leukaemia (AML), a form of blood cancer is placed into the spotlight by Open Access Government

**A**cute myeloid leukaemia (AML) is a form of blood cancer, which affects the white blood cells known as myeloid cells. It is a rapidly progressing form of leukaemia. Blood cells are formed in the bone marrow, which is the spongy tissue found inside the bones. Blood-forming stem cells divide to produce either more stem cells or immature cells that become mature blood cells over time.

A myeloid stem cell becomes one of three types of mature blood cells:

- Red blood cells that carry oxygen to all tissues of the body.
- Platelets that form blood clots to stop bleeding.
- Granulocytes (white blood cells) that fight infection and disease.

Acute myeloid leukaemia (AML) exists in different forms depending on which type of myeloid cell is being produced. The most important subtype is called acute promyelocytic leukaemia (APL). APL makes up about one in 10 cases of AML; it is important because it is treated very differently. A special test can detect a characteristic genetic abnormality in APL.

Acute leukaemia progresses rapidly, unless effectively treated but, especially in younger or fitter patients, it can often be cured with standard treatments.

## What causes AML?

In most cases of AML there is no obvious cause, but it is important to understand that:

- It is not a condition which can be caught from someone else (contagious) and;
- It is not passed on from a parent to a child (inherited).

The risk factors are:

- **Age** – like most forms of cancer AML is more common in older people;
- **Being male** – AML affects slightly more males more than females;
- **Genes** – In the vast majority of cases AML does not run in families. There have been very rare cases of families where AML affects more than one generation. This is very rare, and, in almost all cases, there is no cause for anxiety or for screening tests;

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“Although a doctor may suspect a patient has leukaemia based on signs and symptoms, it can only be diagnosed by laboratory tests. The results of a simple blood count will usually indicate leukaemia although, rarely, a blood count may be normal. Virtually all patients with AML will have bone marrow samples taken to confirm the diagnosis and to help to determine exactly what type of leukaemia a patient has. More specialised tests are often done at the same time.”

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- **Environment** – Although most cases do not have an apparent cause there are some factors such as some chemicals and high levels of radiation which may increase the chance of developing leukaemia. The most common chemical cause is smoking, which is thought to cause about one in four cases and;
- **Other bone marrow diseases** – Some cases of AML affect people who already have a bone marrow disease. The bone marrow diseases most often associated in this way are myelodysplastic syndrome (MDS) and the myeloproliferative neoplasms (MPN).

## Signs and symptoms of AML

The most common signs and symptoms are caused by



the bone marrow being unable to produce enough normal blood cells. The signs and symptoms include:

- Anaemia – due to lack of red blood cells;
- Weakness, tiredness, shortness of breath, light-headedness, palpitations;

---

**“The details of treatment will vary depending on the specific type of AML, age and general fitness. Patients will be given a chance to discuss treatment options and detailed information on their treatment plan before it starts.”**

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- Infections – due to lack of normal white blood cells;
- Infections are more frequent, more severe and last longer;
- Fever, malaise (general feeling of illness) and sweats;
- Purpura (small bruises in skin), nosebleeds, bleeding gums and;

- Bleeding and bruising – due to lack of platelets.

Other signs and symptoms (which may only occur in some forms) include:

- Bone pain, enlarged liver/spleen, swollen gums, skin lumps – these are all caused by collections of AML cells in other tissues;
- Bleeding may be a particular problem in APL and;
- Some patients who have a very high white cell count may develop a condition called leucostasis, in which blood flow is slowed because of thickening of the blood.

### Diagnosis

Although a doctor may suspect a patient has leukaemia based on signs and symptoms, it can only be diagnosed by laboratory tests. The results of a simple blood count will usually indicate leukaemia although, rarely, a blood count may be normal. Virtually all patients with AML will have bone marrow samples taken to confirm the diag-



nosis and to help to determine exactly what type of leukaemia a patient has. More specialised tests are often done at the same time.

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“Acute myeloid leukaemia (AML) exists in different forms depending on which type of myeloid cell is being produced. The most important subtype is called acute promyelocytic leukaemia (APL). APL makes up about one in ten cases of AML; it is important because it is treated very differently. A special test can detect a characteristic genetic abnormality in APL.”

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### Treatment of AML

If you are being treated for any type of leukaemia, you may be asked to consider taking part in a clinical trial. Clinical trials are scientific studies to find the best treatment; you can find more information on our website at [www.leukaemiacare.org.uk/clinical-trials](http://www.leukaemiacare.org.uk/clinical-trials).

Virtually all patients with AML will start treatment immediately. The main exception would be if a patient is very ill with other medical problems and is not fit

enough to receive treatment. Acute leukaemia is often curable with standard treatments, in younger and/or fitter patients. Older or less fit patients will usually have a good initial response to treatment, but the condition will most often come back, this is known as a relapse.

The main ways in which AML is treated are:

- **Chemotherapy** – Cell-killing drugs;
- **Radiation therapy** – Usually only given as part of a stem cell transplant in AML;
- **Stem cell transplant** – Younger/fitter patients may be given a stem cell transplant (bone marrow transplant). This is done using healthy stem cells from a donor. This may be done if chemotherapy does not cure the disease.

Chemotherapy is the use of cell-killing drugs. These kill the cancer cells and/or stop them from dividing. Chemotherapy is usually given in blocks or ‘cycles’ of

treatment. One cycle of treatment will consist of a series of doses of chemotherapy followed by a break for the healthy cells to recover.

AML cells may be found in the fluid around the brain and spine (called CSF). If this is the case, then chemotherapy includes injections into this fluid. This is called intrathecal chemotherapy.

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**“Virtually all patients with AML will start treatment immediately. The main exception would be if a patient is very ill with other medical problems and is not fit enough to receive treatment. Acute leukaemia is often curable with standard treatments, in younger and/or fitter patients. Older or less fit patients will usually have a good initial response to treatment, but the condition will most often come back, this is known as a relapse.”**

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Chemotherapy is normally given as a combination of drugs. If patients with APL are given standard AML chemotherapy, there is a high risk of severe bleeding. This can be avoided by giving a drug called retinoin or retinoic acid which makes the APL cells mature and die off naturally. Sometimes an arsenic based drug is used instead, usually as a second line treatment. Retinoin and arsenic treatment are sometimes given along with standard chemotherapy.

The details of treatment will vary depending on the specific type of AML, age and general fitness. Patients will be given a chance to discuss treatment options and detailed information on their treatment plan before it starts. The side effects of treatment vary between different types of treatment and different patients. Patients will be given detailed information about any likely side effects before treatment starts.

### Questions to ask your doctor about AML

We understand going through a blood cancer journey can be difficult. It may help to talk to a close friend or relative about how you are feeling. Here are some questions that may be useful to ask your doctor.

- How would I know if I had AML?
- What tests will I need to have?
- What will the tests show?
- How long will the results take?
- How rare is AML?
- What sort of treatment will I need?
- How long will my treatment last?
- What will the side effects be?
- Is there anything I should or shouldn't eat?
- Will I be able to go back to work?
- Where can I get help with claiming benefits and grants?
- Where can I get help dealing with my feelings? ■

For more information, please visit these links:

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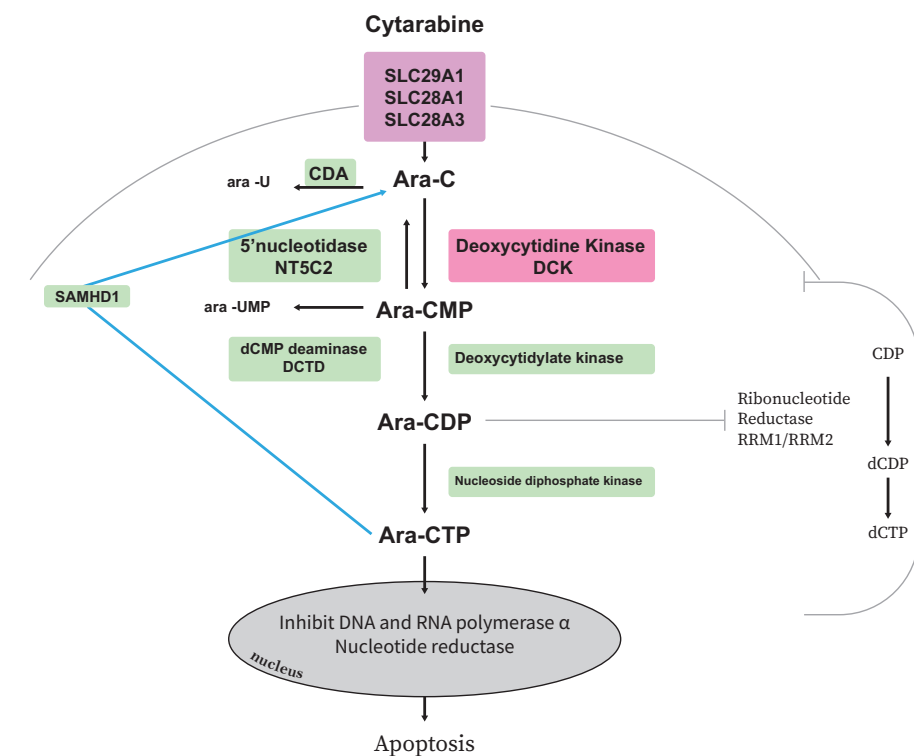
# Acute myeloid leukaemia (AML) and cytarabine pharmacogenomics

Professor Jatinder Lamba from the Department of Pharmacotherapy and Translational Research gives an in-depth perspective on acute myeloid leukaemia (AML) and cytarabine pharmacogenomics

**A**cute myeloid leukaemia (AML) is the cancer of the myeloid precursor stem cells characterised by the appearance of immature, abnormal myeloid cells in bone marrow and other organs. AML is a very heterogeneous disease with various subtypes classified based on the morphology, immunophenotype and cytogenetics.

Despite advances in recent years, the 5-year survival rates for AML are ~68% for children younger than 15 years and ~57% for children between 15-19 years. The utilisation of multiple clinical, cytogenetic and other molecular features that are associated with the response has helped in identification of patient's more/less likely to respond.

Additionally, minimal residual disease (MRD) after induction 1 has been identified as a powerful predictor of poor outcome. The nucleoside analog, cytarabine (ara-C), has been the mainstay of AML chemotherapy for more than 40 years<sup>1,2</sup>. The most common treatment strategy includes induction therapy, which consists of 3+7 regimen with daunorubicin (45 mg/m<sup>2</sup> per day for 3 days) and cytarabine 100mg/m<sup>2</sup> for 7 days). This induction regimen has been shown to induce remission in 60-70% of patients. Cytarabine, in combination with varying doses of anthracycline and addition of a third agent (cladribine, clofarabine and more recently CD33 targeted therapies such as gem-



tuzumab ozogamicin etc.), has been the standard of practice for a few years now.

However, despite the major advances in AML drug combination strategies and treatment options, resistance and disease remission represent our major obstacle to reach the desired outcomes<sup>3,4</sup>. Although a significant proportion of patients achieve complete remission after initial therapy, most of these experience relapse which has a significant impact on long-term survival rates<sup>5</sup>.

One of the most common and severe toxicities associated with cytarabine is myelosuppression. Cytarabine is a

prodrug requiring activation to ara-CTP through series of phosphorylation steps and this triphosphate form of ara-C inhibits DNA polymerase- $\alpha$  and  $\beta$  and competes, with deoxycytidine triphosphate (dCTP) for incorporation into DNA and RNA thereby inhibiting DNA synthesis and triggering leukaemic cells<sup>6-8</sup>. Thus, intracellular levels of the active ara-CTP are critical for achieving significant leukaemic cell death. Previous *in vitro* studies have shown that the intracellular concentrations of ara-CTP are higher in ara-C sensitive cells, than in resistant cells.

Further, leukaemic cells from patients with chronic myelogenous leukaemia

(which is not responsive to ara-C), have only half the ara-CTP levels, as compared to leukaemic cells from patients with AML (which is responsive to ara-C)<sup>4</sup>. Thus, one of the mechanism underlying ara-C resistance is insufficient intracellular levels of the active triphosphate metabolite ara-CTP, which may be due to:

- Inefficient cellular uptake due to low levels of the transporters (SLC29A1, SLC28A3 and SLC28A1);
- Reduced activation due to alterations in enzymes as DCK, CMPK1;
- Increased inactivation rates due to NT5C2, CDA, or DCTD and more recently identified enzyme SAMHD1<sup>9</sup>; and/or
- Increased cellular dCTP pools, that can compete with DNA incorporation of ara-CTP and inhibit DCK activity which, in turn, are regulated by the enzyme ribonucleotide reductase (consisting of RRM1 and RRM2 subunits). Figure shows metabolic pathway and thus key players that might impact cytarabine activation and thus its therapeutic benefit.

Single nucleotide polymorphisms (SNPs) in genes involved in transport, activation and inactivation of cytarabine can influence the intracellular ara-CTP levels by influencing the expression and activity of these genes and this, in turn, can also influence the clinical outcome of the patients treated with ara-C.

Several studies so far have investigated some of the key players and have shown an association of SNPs within key candidate cytarabine metabolism genes and clinical

response in AML patients, or with cytarabine in vitro chemosensitivity<sup>10</sup>. Our group has previously reported an association of SNPs in DCK, NT5C2 and RRM1 with intracellular levels of ara-CTP in leukaemic cells, as well as clinical response to AML<sup>11-15</sup>.

Despite these efforts, one of the biggest gaps in the literature is that most of the previous studies have focused on selective genes and so far, no study has performed a comprehensive and integrated analysis of genetic variation in the complete cytarabine metabolic pathway. It is important to note that simultaneous contribution of multiple genes can impact the drug activation and thus response, so it is very critical to the field of pharmacogenomics around AML/paediatric and AML is still in its infancy.

In summary, AML is a very heterogeneous disease, with multiple subgroups that impact the therapeutic outcome. Pharmacogenomics has the potential to improve the clinical outcome in AML, although there are limited studies, results so far indicate the potential for SNPs in activating, inactivating enzymes, as well as drug transporter to be of clinical relevance. The integration of pharmacogenetic markers with prognostic markers in larger clinical cohorts can advance our ability to design personalised therapy for patients to achieve greatest therapeutic benefit.

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Lamba Lab members involved in the cytarabine pharmacogenomics research include AbdelRehman Elsayed, Dr. Roya Rafiee and Salma Bargal



**Professor Jatinder Lamba**  
 Department of Pharmacotherapy and Translational Research  
 Tel: +1 352 273 6425  
[jlamba@cop.ufl.edu](mailto:jlamba@cop.ufl.edu)  
[jatinderklamba@ufl.edu](mailto:jatinderklamba@ufl.edu)  
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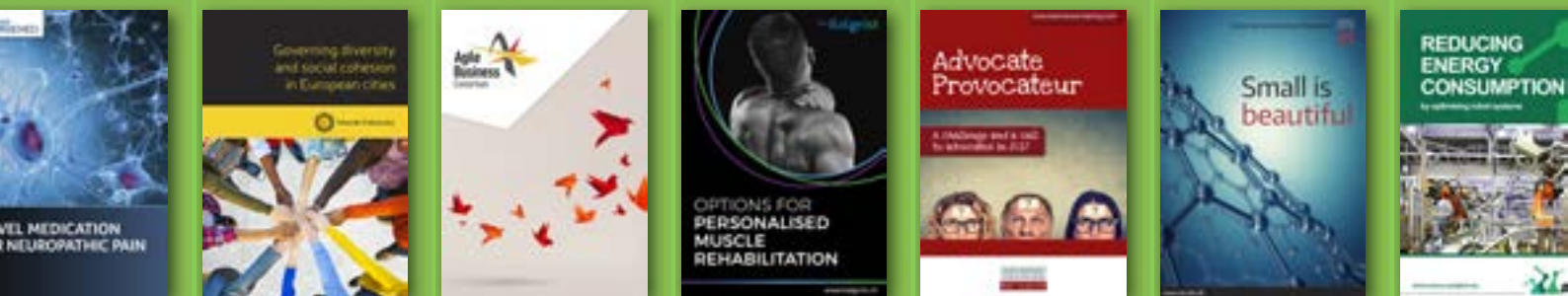
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# Chronic kidney disease – advancing opportunities for personalised treatment

Cecilia Van Cauwenberghe from Frost & Sullivan explores advancing opportunities for personalised treatment of chronic kidney disease (CKD) and research into membranous nephropathy (MN)

According to The National Institute of Diabetes and Digestive and Kidney Diseases Health Information Center, in the US alone, approximately 30 million adults are estimated to have chronic kidney disease (CKD), a condition in which the kidneys result damaged and cannot filter blood efficiently. Hence, excess fluid and waste from the blood remain within the body leading to a broad spectrum of health problems. Remarkably, around 48% of people exhibiting a severely reduced kidney function but not on dialysis are not aware of having CKD. Indeed, 96% people with kidney damage or mildly reduced kidney function are not aware of having CKD.

In Europe, statistics from the European Renal Association and the European Dialysis and Transplant Association (ERA-EDTA), exhibit that 10% of the population is affected by CKD. More dramatically, around 70 million Europeans have lost some of their kidney functions and hold a high risk of becoming dependent on renal replacement therapies such as dialysis or transplantation.

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**“More consistent and sustainable approaches focusing on prevention instead of treatment are critical. Primary prevention fundamentally involves lifestyle changes attempting to derive in a healthy, active and long-lived population.”**

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Among the principal risk factors for developing CKD, adults with diabetes, high blood pressure, heart disease, obesity, metabolic syndrome, in addition to genetic predisposition, hold a higher risk of developing CKD (Obrador et al., 2017). However, many patients have been diagnosed without such health antecedents. Membranous nephropathy (MN) represents an exceptional glomerular lesion that is the most common cause of idiopathic nephrotic syndrome (INS) in non-diabetic adults. Even though accepted treat-

ment regimens include steroids/cyclophosphamide, calcineurin inhibitors and B cell depletion, the road ahead an efficient treatment that remarkable improve the renal function is still poor.

## **CKD as a global public health concern**

While not included among the most hazardous health problems, CKD is becoming epidemiologically and economically remarkable due to its increasing prevalence. The annual costs incurred for a dialysis patient in Europe are estimated over €80,000 while totalling around \$95,000 in the US. The European Kidney Health Alliance (EKHA) also warns about CKD. Indeed, the treatment of CKD and of end-stage renal disease (ESRD) entails extensive societal costs. Expenditure is even higher when considering in-hospital hemodialysis waiting for renal replacement therapy (RRT) in the equation. An alternative, less expensive forms of RRT such as peritoneal dialysis and home hemodialysis are gaining attention to alleviate financial pressure. However, costs for CKD should also include non-renal healthcare costs associated with other risks or complications that patients with CKD must deal with (Vanholder et al., 2017).

According to Frost & Sullivan investigations, the global market for CKD in 2017 reached \$12.9 billion. The global market for CKD is expected to rise to nearly \$15.6 billion by 2022, growing at a compound annual growth rate (CAGR) of 3.9% from 2017 to 2022.

## **Technology approaches addressing early diagnostics and treatment of CKD**

### **MicroRNAs as biomarkers in CKD**

Biomarkers constitute the battle horse in disease diagnostics and in fact, can successfully help to diagnose CKD at early stages using microRNAs. MicroRNAs are present, in a highly stable form and readily quantifiable





amount, in tissues and body fluids, such as urine. MicroRNAs have prevalent significance as regulators in the kidney. Therefore, urinary microRNAs characteristically released from the nephron in abundant quantities strongly reflect the status of the kidney through the altered microRNA expression in the kidney. MicroRNAs can also be released into the lumen by different cells in specific regions of the nephron, therefore allowing identifying several pathological states, as well as, informing about risk and response to specific therapies (Wonnacott et al., 2017). These biomarkers are commended as novel tools to become the personalised management of renal diseases a reality.

### **Blocking peptides and molecular mimicry as treatment for CKD**

Blocking peptides, also called protein mimotopes, represent small therapeutic peptides capable of preventing protein-protein interactions due to the selective mimicking of native binding domains. This technology is very inexpensive and significantly facilitates the simple design and production of therapeutic agents based on blocking peptides at large scale, thus accelerating trials

in both in vitro and in vivo experimental disease models (Havasi et al., 2017).

As an ideal peptide target because of its capability to rapidly filter and absorb small molecules, the kidneys and more precisely, tubular epithelial cells, are perfectly suited to advance the therapeutic road in this direction. Blocking peptides are also attractive due to their advantages in comparison with conventional therapies. The half-life of peptides is extended in the glomerulus compared with the bloodstream, so that, therapeutic agents capable of penetrating the glomerular matrix are more suitable for treating a broader spectrum of renal diseases, including ischemia, membranous nephropathy, focal and segmental glomerulosclerosis and renal cell carcinoma, among others. This growing reagent class of drug candidates also comes with ease of administration, high binding affinity and minimal adverse side-effects.

### **Medical advances and paradigm change in the treatment of MN**

The role of PLA2R antibody in treatment of MN Membranous nephropathy (MN) is one of the leading causes

of nephrotic syndrome in adults. Alkylating agents such as cyclophosphamide or chlorambucil alone or in combination with steroids are known to achieve remission of nephrotic syndrome more effectively than conventional approaches in the treatment of MN (Ronco, 2017).

However, the risk of myelotoxicity, infections and even cancer is still concerning. Calcineurin inhibitors, on the other hand, can restore proteinuria but are nephrotoxic. Therefore, the advent of nephritogenic autoantibodies against podocyte M-type phospholipase A2 receptor (PLA2R) and thrombospondin type-1 domain-containing protein 7A (THSD7A) antigens are stipulated to deliver a radical pathophysiological rationale for interventions specifically targeting B-cell lineages and hence prevent antibody production and subepithelial deposition (Couser, 2017).

The most common medication known using this approach is the anti-CD20 monoclonal antibody rituximab, which has been supposed to safely achieve remission of proteinuria in approximately two-thirds of patients with MN. An integrated evaluation of serology and proteinuria can be used to match patients and treatment protocols using an individually tailored approach based on PLA2R-related disease (Cattran and Brenchley, 2017).

In these cases, remission can be predicted by anti-PLA2R antibody depletion, while relapse can be foreseen by antibody re-emergence into the circulation. Consequently, companion diagnostics appear beyond the promise through B-cell modulation and plasma cell-targeted therapy in anti-CD20 resistant forms of the disease, thus leading to a new therapeutic paradigm for patients suffering from MN.

## Final remarks

The present status of CKD still reflects a crucial need for a fundamental improvement in several areas of attention. An in-depth understanding of the genetic and environmental causes of CKD and associated pathologies is essential. On the other hand, public health goals in terms of programmes and network assistance are also indispensable to guarantee a healthy, active population, involving public and private stakeholders to enhance both research and clinical outcomes.

More consistent and sustainable approaches focusing on prevention instead of treatment are critical. Primary prevention fundamentally involves lifestyle changes attempting to derive in a healthy, active and long-lived population. Secondary prevention is focused on the prevention of many other related chronic diseases, such as diabetes mellitus, hypertension, cardiovascular disease, liver disease, cancer and pulmonary disorders.

## Acknowledgements

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**Cecilia Van Cauwenberghe, Ph.D., MSc, BA**  
Associate fellow and senior industry analyst

TechVision Group, Frost & Sullivan

Tel: +1 210 678 3623

Cecilia.VanCauwenberghe@frost.com

www.frost.com

www.twitter.com/Frost\_Sullivan

# Is precision medicine for membranous nephropathy a dream?

Professor Pierre Ronco and Dr Hanna Debiec discuss the viability of precision medicine in treating patients with the rare disease membranous nephropathy

**M**embranous nephropathy (MN) is a rare disease that affects the kidney filter (glomerulus) and induces a massive loss of proteins in the urine. Considerable progress has occurred in the diagnosis and management of patients since the identification of the major antigens, recognised in the glomerulus by toxic antibodies circulating in the blood. Because the antigens are normally present in the glomerulus, one can conclude that MN is auto-immune in nature, and thanks to the recent advances in the disease pathogenesis, it can serve as a model for most organ-specific auto-immune diseases. The most prevalent antigen identified in 2009, the receptor of the phospholipase A2 (PLA2R1), is localised on the podocyte, a major cell of the glomerular filter where it serves as target for circulating antibodies.

## **Diagnosis of membranous nephropathy: Now possible with a simple serological test**

Until recently, the diagnosis of MN required a kidney biopsy, an invasive diagnostic procedure with the risk of bleeding observed in less than 5% of patients. The development of assays of circulating anti-PLA2R1 antibodies and their transfer to clinical practice has been amazingly fast. The first immunofluorescence (IF) test used biochips coated with cells expressing the antigen, incubated with the patients' sera. The ELISA using the extracellular domain of human PLA2R1

coated to plastic wells enables a more quantitative and faster determination of anti-PLA2R antibodies, but it is a little bit less sensitive than IF. Detection of PLA2R1 antigen in immune deposits in biopsy specimens is also possible with the use of commercial antibody after a retrieval step to unmask PLA2R1 epitopes (domains of the antigen PLA2R that are recognised by the antibodies). These tests have ushered in a new era of precision medicine. Seventy to 80% of patients with MN have mounted an immune response against PLA2R1, which serves as a diagnostic signature since PLA2R1 antibodies are specific for this disease.

## **Monitoring patients with membranous nephropathy: Beyond proteinuria**

For a long time, proteinuria was the only variable to follow disease activity. Now that specific antibodies have been identified, it has been shown that levels of these antibodies also predict outcome. High titers are correlated with a lower chance of spontaneous or treatment-induced remission, and a higher risk of the emergence of a nephrotic syndrome in non-nephrotic patients, and of renal function deterioration.

Furthermore, anti-PLA2R1 antibodies appear to be sensitive markers of treatment efficacy. Partial or complete depletion of anti-PLA2R antibodies precedes clinical remission, which is disappearance of proteinuria, by sev-

eral weeks or months, while re-emergence or an increase of these antibodies precedes by several weeks a renal relapse. The time lag of several months from immunological remission (depletion of antibodies) to renal remission is most likely accounted for by resorption of immune deposits and repair of the glomerulus. Even more, anti-PLA2R1 antibody titers at the end of therapy are predictive of later outcomes.

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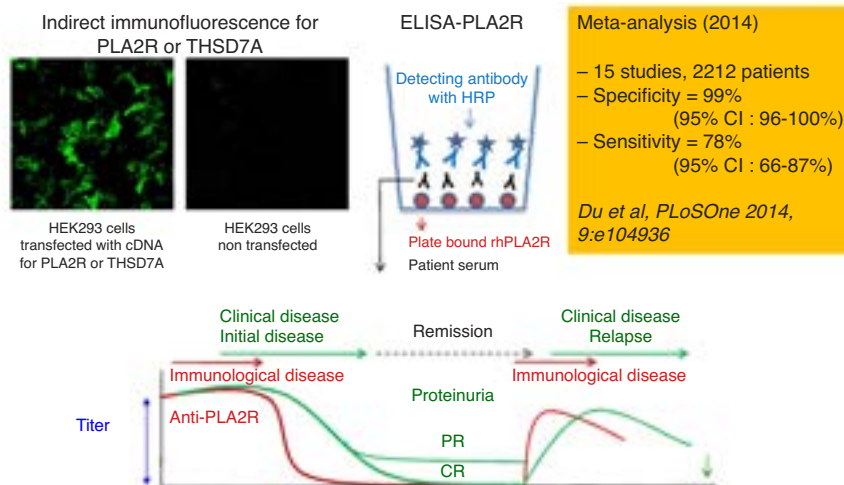
**"Because the rate of remission (including partial remissions) does not exceed 70% with current immunosuppressive treatments, we hope that in future trials, close monitoring of anti-PLA2R1 antibody titer and epitope specificity as well as regulatory T-cells will allow a more personalised adaptation of treatment leading to increased rate of complete remission."**

---

## **Toward a serology-based approach to treatment**

Treatment of MN is controversial because of a high rate of spontaneous remission (up to 40%) and toxicity of immunosuppressive drugs that are used to treat patients with persisting nephrotic syndrome. Patients should not be overexposed to toxic medication if they don't need it. This is the reason why treatment is often delayed by 6 months to give the patients a chance to undergo spontaneous remission. We think that the international guidelines should be revised to include anti-PLA2R1 antibody in the

### Serological tests for the diagnosis and monitoring of patients with membranous nephropathy



This picture shows the results of immunofluorescence test for the detection of anti-PLA2R1 antibodies (upper left) and those of a meta-analysis of >2,000 patients showing that anti-PLA2R1 antibodies are highly specific for MN and their sensitivity is close to 80% (upper right).

The scheme at the bottom shows that anti-PLA2R1 (in red) disappear before proteinuria (in green) and reappear before clinical relapse.

decision algorithm for patients with idiopathic MN. Measurement of anti-PLA2R1 antibodies may indeed obviate the need for a “wait and see” period of 6 months, and allow for more rapid treatment decisions. We recommend that antibodies are assessed every month in patients with a high level, and every two months in patients with low levels before starting immunosuppressive therapy to avoid unnecessary treatment in patients entering immunological remission (substantial decrease or disappearance of antibodies). This recommendation does not apply to patients with rapidly declining renal function, in whom a prompt initiation of immunosuppression is warranted.

If immunosuppression has been started, we recommend that antibodies be assessed every month during the first 6 months. Although the rate of antibody reduction varies among

studies, the general picture is that antibodies dramatically decrease during the first 3 months, and disappear over 6 to 9 months followed by remission of proteinuria over 12 to 24 months. Patients with a prompt and robust immunologic response may receive shorter than usual courses of immunosuppressive agents, whereas a conversion to an alternative therapy or a reinfusion of rituximab (for patients started on this drug which targets the B-lymphocytes involved in antibody production) should be considered in those who do not show a significant reduction in antibody titer at 6 months.

#### Toward more precision medicine: Lessons from molecular and cellular studies

There is more to come. Very recent studies by our group and a collaborating group in Nice suggest that diffusion of the immune response to several

domains of the PLA2R1 antigen (a phenomenon called epitope spreading) was associated with a lower rate of remission after 6 months in patients treated with rituximab. We also showed that a population of T-lymphocytes, the regulatory T-cells, involved in the control of auto-immunity, was decreased in patients with severe MN and that those who responded to rituximab had a lower percentage of regulatory T-lymphocytes at onset of treatment and an increased percentage of those cells as early as 8 days after starting treatment.

Because the rate of remission (including partial remissions) does not exceed 70% with current immunosuppressive treatments, we hope that in future trials, close monitoring of anti-PLA2R1 antibody titer and epitope specificity as well as regulatory T-cells will allow a more personalised adaptation of treatment leading to increased rate of complete remission.

# Inserm

**Pierre Ronco**  
Professor  
Sorbonne Universités (UPMC)

**Hanna Debiec**  
Doctor  
Institut National de la Sante et de la Recherche Medicale  
Tel: +33 1 560 16639  
pierre.ronco@aphp.fr  
[http://cordis.europa.eu/project/rcn/104845\\_en.html](http://cordis.europa.eu/project/rcn/104845_en.html)



# Understanding mental health – through our stomachs

Alex Schubert from the European College of Neuropsychopharmacology (ECNP) explores the link between our mental health and what we eat

Every day we consume a wide variety of substances with the specific goal of modifying our mental states. These can range from substances that are overtly mood-altering, such as coffee and alcohol, to those of a more diffuse impact, such as chocolate and folic acid, to out-and-out comfort foods, whose effects – like Proust’s famous madeleine moments – are less chemical than they are sentimental. We all instinctively know there is a connection between what we eat and how we feel, but as the madeleine moments show, that connection is multi-layered and maddeningly elusive. Its scientific basis, not altogether surprisingly, is also very poorly understood.

Nevertheless, we are finding out more and more. Research is revealing suggestive linkages, giving rise to a dynamic new field, ‘nutritional psychiatry,’ which is trying to unpick the complex web of interactions that connect what we eat with what we feel and how we behave.

Chair of the European College of Neuropsychopharmacology’s Nutrition Network Suzanne L. Dickson, professor of neurobiology at the University of Gothenburg, Sweden, explains what is at stake: “There’s a lot of accumulated wisdom about how nutrition meshes with brain health, but not much hard science. In particular, what we’re missing is a means to connect the many insights we’ve acquired on food’s effects to the underlying neurobiology and, in doing so, develop a path that might lead one day to actual nutrition-based treatments.

“The promise of nutritional psychiatry is that by identifying which nutritional components truly matter for brain health and how these interact with the body’s metabolic, endocrine and other signalling processes, we can work out how to modulate neuronal function and, in turn, influence behaviour.

“We’re only at the beginning, but if we can isolate the environmental, lifestyle and genetic factors that determine nutritional responses, bearing in mind that humans are very different in the food they eat and how they process it, we can begin to envisage a future of personalised nutrition.”

The importance of food for the brain’s functioning is easily inferred from how the brain works. Maintaining its composition, structure and synaptic function relies on access to the appropriate nutrients, including lipids, amino acids, vitamins and minerals. These can only be obtained in the quantities we need them through the intake of nutrients in the food we eat.

Moreover, endogenous gut hormones, neurotransmitters and the gut microbiota-derived substances that mediate brain-gut-microbiota communication are directly affected by the composition of our diets. The implications are very important: if, as it appears, food intake and food quality have a direct impact on brain function, by modifying that intake we have the potential to influence cognitive performance and overall brain health.

We already have many interesting leads. Mounting evidence points to a healthy diet, rich in polyphenols, B-vitamins, polyunsaturated fatty acids and nutritional supplements, having a positive influence on mental health, cognitive performance and stress reactivity. There are reasons to believe, for example, that omega-3 polyunsaturated fatty acids can improve cognition and ameliorate anxiety and that dietary omega-3 polyunsaturated fatty acids supplementation protects against the development of cognitive impairment, hyperactivity of the hypothalamic-pituitary-adrenal (HPA) axis and neuro-inflammation.

Dietary exposure to high levels of polyphenols, B-vita-

mins and polyunsaturated fatty acids during middle age has also been found to correlate with better cognitive performance later in life. A recent study has even suggested that plasma monounsaturated fatty acids can significantly influence the efficiency of functional connectivity in the brain and enhance general intelligence.

We also have a large body of epidemiological evidence that points strongly to the influence of diet on mental function and brain health. Early life malnutrition studies show that proper nutrition is essential for brain development in childhood and that these effects carry through right into adulthood and old age. At any stage of life, in fact, an improved diet quality is associated with better cognitive fitness and reduced risk of cognitive decline. Not only has the intake of antioxidant polyphenols been linked to improved cognitive abilities in the elderly, but higher serum vitamin D concentrations have been shown to be closely associated with better attention and working memory performance in the over-65s, pointing to a frontline role for diet in the fight against cognitive decline. For an ageing population facing rising levels of neurodegenerative dysfunction, these are very encouraging findings.

New evidence has also brought to light the role that the intestinal microbiome plays in the development and functioning of the brain, with data showing that the gut microbiota is critically implicated in the body's ability to manage stress and respond to affective disorders, such as anxiety and depression. The way stress can negatively affect the gut microbiota and digestive health opens up the promising possibility that stress might also be lessened if the gut microbiota can be appropriately regulated via a precision diet. While not minimising the impact of other complex determinants, including genetics, environment, lifestyle and mode of delivery, the close association between diet, nutrition, the digestive organs and mental health promises whole new lines of possible treatment research.

Yet, while compelling links between diet and brain health abound, identifying *causes* is another matter. "The evidence is pretty clear: nutrition, stress susceptibility, brain health and mental function are somehow bound up together," says Suzanne Dickson. "But the evidence is correlational. There is a gap in understanding how these effects come about. What's needed now are much more robust intervention studies in large cohorts to identify exactly which mechanisms are



*Nutrition scientist Suzanne L. Dickson,  
University of Gothenburg*

involved in connecting nutrition and neuronal functioning and how these mechanisms can be manipulated by improved dietary habits to enhance people's mental health".

This was the rationale behind the ECNP Nutrition Network, to pool European expertise in nutrition and neuroscience and help give nutritional psychiatry a more secure, evidence-based grounding. The Network includes researchers from academia as well as Europe's leading food companies, attracted by the enormous therapeutic potential inherent in the field. "The long-term possibilities are immense," says Dickson.

"Simply by adjusting what we eat we are looking at being able to lift general standards of health and well-being and reduce the growing social and economic cost of mental illness. Right now, it's one of the most exciting areas of mental health research. We are very optimistic". ■

**Alex Schubert, Ph.D.**  
**Executive Director**

European College of Neuropsychopharmacology (ECNP)

Tel: +31 88 75 69 555

[secretariat@ecnp.eu](mailto:secretariat@ecnp.eu)

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

[www.twitter.com/ecnptweets](https://www.twitter.com/ecnptweets)

# Disease-associated myosteatorsis in people with cancer: Can it be treated?

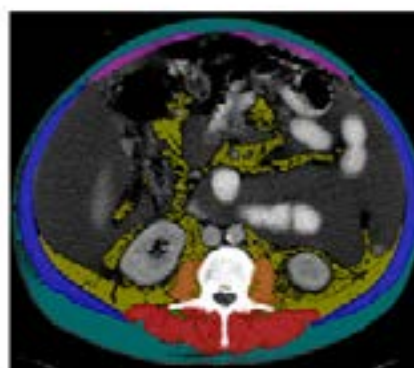
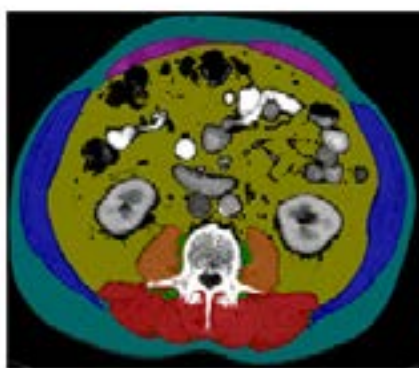
**P**athological fat infiltration into muscle is a feature of disease-induced muscle loss that significantly associates with shorter survival in people with cancer. Fat is associated with skeletal muscles in the form of intra-myocellular lipid droplets within the cytoplasm of myocytes as well as intermuscular 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 steatorsis. Myosteatorsis (steatorsis of the muscle) is a pathological phenomenon reflecting an impairment of synthesis and elimination of triglyceride.

Myosteatorsis 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



*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*

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



**Skeletal Muscle**

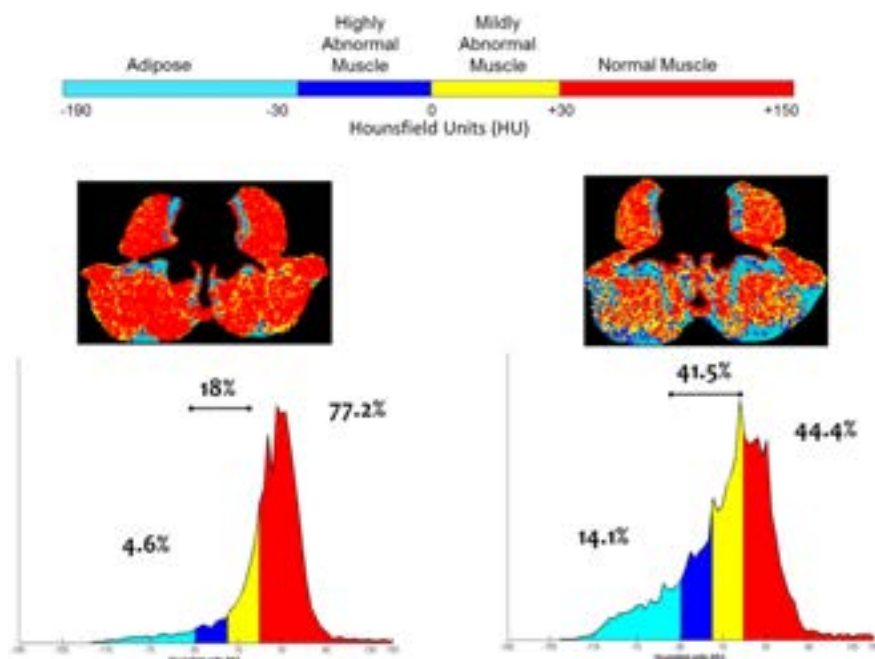


**Adipose Tissue**



*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 myosteatorsis. 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 myosteatorsis, 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 test the biological efficacy of fish oil to reverse cancer- associated myosteatorsis in a cancer population known to exhibit myosteatorsis, 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 myosteatorsis). We expect that this research will verify the tantalizing evidence we have in hand that

suggests an improvement in pathological features of myosteatorsis 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.



**Dr Vera Mazurak**

University of Alberta

[www.afns.ualberta.ca/StaffProfiles/AcademicProfiles/Mazurak.aspx](http://www.afns.ualberta.ca/StaffProfiles/AcademicProfiles/Mazurak.aspx)



# Ground-breaking results for Huntington's Disease (HD) research

Svein Olaf Olsen and Maiken Arnesen from the European Huntington Association reveal their thoughts on a recent and significant breakthrough concerning Huntington's Disease (HD) research

The 11th December 2017 will probably go into history along with the discovery of the Huntington gene in 1993. On this date, IONIS Pharmaceuticals announced the results from the first Huntington lowering trial in humans. The result exceeded all expectations and represents a significant step towards a possible treatment for the hereditary – Huntington Disease (HD).

Huntington's Disease (HD) is a fatal genetic disorder that causes the progressive breakdown of nerve cells in the brain. It deteriorates a person's physical and mental abilities during their prime working years and until now there has been no cure. HD is known as the quintessential family disease because every child of a parent with HD has a 50/50 chance of carrying the faulty gene ([www.hdsa.org](http://www.hdsa.org)).

In Europe, we see a prevalence of 7-12 patients per 100,000. This means that in The European Union you find between 36,000 and 52,000 people with HD. In addition, you have more than 250,000 affected as children or grandchildren of an HD patient, says Astri Arnesen, President of The European Huntington Association (EHA).

Firstly, to find a drug that can slow down the development of the disease or even stop the progression is important for the affected human being and her/his family, is the best news, Astri Arnesen continues.

But it will also have enormous benefits on the health budgets. Studies from UK (European Journal of Neurology published by John Wiley & Sons Ltd on behalf of European Academy of Neurology 2016) show that the annual cost per person with HD was £21,605. The largest proportion of this cost (65%) was due to informal care (£14,085), Astri Arnesen says.

## Best Christmas gift ever for the Huntington community

For all of us involved in HD, the lowering results was: "The Best Christmas gift ever for the Huntington Community!", Astri Arnesen underlines

The compound has so far proven the ability to lower the expression of mutant huntingtin considerably. "This gives us reason to believe that the root cause of HD can be targeted and influenced," Astri Arnesen says. The treatment might slow down the progress of Huntington's and improve symptoms.

"I almost cried when Kristina Bowyer, the Executive Director, Patient Advocacy in Ionis, informed me about the amazing results," Astri continues.

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**"Huntington's Disease (HD) is a fatal genetic disorder that causes the progressive breakdown of nerve cells in the brain. It deteriorates a person's physical and mental abilities during their prime working years and until now there has been no cure. HD is known as the quintessential family disease because every child of a parent with HD has a 50/50 chance of carrying the faulty gene."**

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## What is Huntingtin lowering?

'Switching off' the cause of Huntington's Disease was the first thought that appeared when the HD gene was discovered in 1993. Huntingtin lowering drugs – previously called 'gene silencing' drugs – reduce the activity of the HD gene.

The drug tells the cells to delete the 'message' from the 'sick' gene causing the disease. In other words: it 'shoots the messenger'. The first major progress in achieving this came around a decade ago, when several studies in HD mice reported success in reducing the activity of



the gene. And now the trial has been carried out in humans – with positive results.

The date of 11th December will therefore probably go into history along with the discovery of the HD gene in 1993. It's a milestone and big breakthrough.

### **What is the next step?**

There is still a huge job to be done and there may be setbacks, in recent weeks we have celebrated, and hope is raised among all HD affected families. We needed this great news and it encourages us to continue the hard work ahead of us, Astri states.

The pharma company Roche will now take over further development. Planning of the third phase of the trial has already started. This phase requires several hundred participants.

Astri comes with an appeal to the Huntington community: "We encourage potential participants to contact the HD clinics that Roche will choose for the trial. It is not yet known where and when the Phase III trial will

be, but Roche announces that they want to act as soon as possible", says Astri Arnesen, President of the European Huntington Association.

"And the best part of it all – this is only the beginning. There are several other very exciting Huntingtin Lowering trials being done right now – or planned to start soon. I hope all HD affected enter 2018 with the reassurance that we are moving closer to our goal", Arnesen concludes. ■

**Svein Olaf Olsen**  
**Member at large**

**Maiken Arnesen**  
**Web editor**

European Huntington Association  
Tel: +47 90 20 20 31  
[astri@eurohuntington.org](mailto:astri@eurohuntington.org)  
<http://eurohuntington.org/>  
[www.twitter.com/eurohuntington](http://www.twitter.com/eurohuntington)

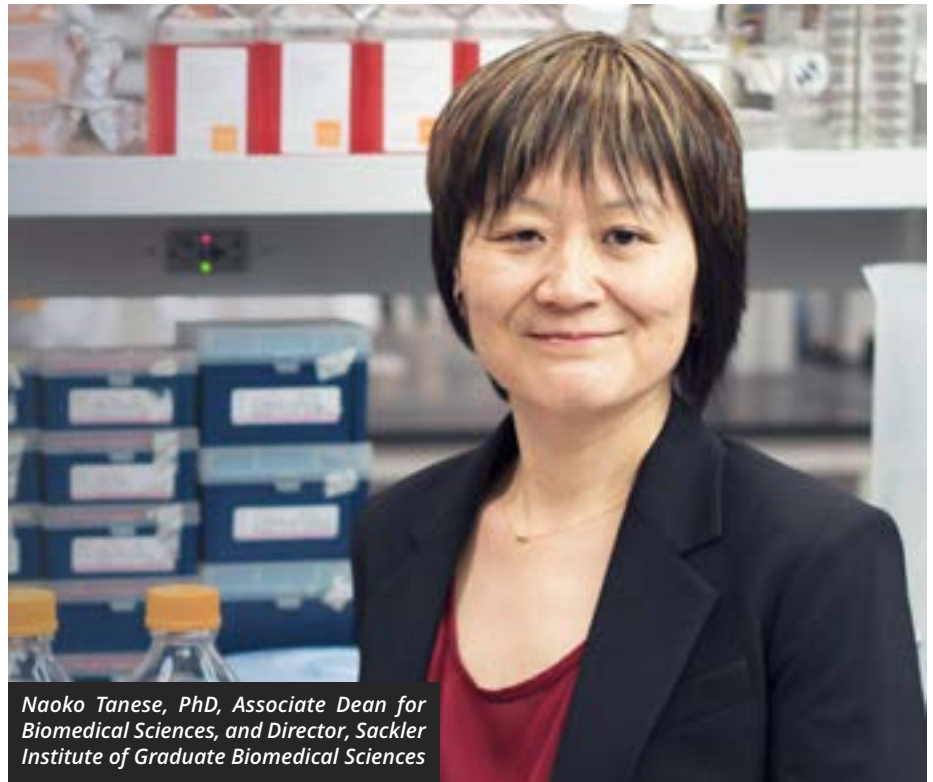
# What's in an aggregate? Therapeutic intervention in Huntington's

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

**H**untington'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.

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



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

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.



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

New York University School of Medicine

Tel: +1 212 263 8945

[tanesn01@med.nyu.edu](mailto:tanesn01@med.nyu.edu)

<https://med.nyu.edu/faculty/naoko-tanese>

[www.twitter.com/nyuschoolofmed](https://www.twitter.com/nyuschoolofmed)

<http://sackler.med.nyu.edu>



# Now is the time to finally prioritise lung cancer

CEO of Roy Castle Lung Cancer Foundation, Paula Chadwick, explains why now is the time to finally prioritise lung cancer

The events of Tuesday 21st November 2017 have the potential to change the lives of thousands of people in England. It was the day NHS England finally prioritised early detection of lung cancer.

As the UK's biggest cancer killer, you can be forgiven for asking why it is only now that lung cancer is having a moment in the spotlight. Lung cancer is a complex disease and can be difficult to diagnose. It is also an illness with a certain perception due to its association with smoking. According to a recent survey by the Global Lung Cancer Coalition (GLCC), 1 in 4 people have less sympathy for people with lung cancer than those with other cancers.

Nearly 36,000 people die of lung cancer every year. That's one person every 15 minutes. It's also more than breast, cervical and bowel cancer combined, the three cancers which all have an existing NHS screening programme.

**"As with the existing screening programmes, the lung health check will only be available to certain people, typically those aged between 60 and 75 with a history of smoking. This is because lung cancer predominately affects the older generation and people who have smoked; approximately 85% of cases are smoking-related."**

Whilst the proposed scheme is a lung health check rather than a screening programme, the essence of it and its aim are the same – find cancer at the earliest stage when it is easiest to treat.

People with early-stage lung cancer have up to a 73% chance of surviving for 5 years or more, staggeringly higher than the current one, 5 and 10 year statistics which stand at 38%, 10% and 5% respectively.



Compare survival rates to breast, cervical and bowel cancers and it is easy to see why these lung health checks are desperately needed and something we know works.

In 2017, we started to fund our own Lung Health MOT Check in Nottingham. Patients from five surgeries were invited to attend with those considered high risk offered a CT scan. The scheme has already started to identify people who, unbeknown to them, have lung cancer.

## Bill's story

"I had a call about the check and thought I may as well go. I'd had a cough for a while but wasn't concerned about it and I certainly wouldn't have thought to go to the doctors. I try not to pester my doctor for little things.

"At the initial appointment, I was told I needed to have a CT scan and then a PET scan. They then confirmed



**Paula Chadwick, CEO of Roy Castle Lung Cancer Foundation**

As with the existing screening programmes, the lung health check will only be available to certain people, typically those aged between 60 and 75 with a history of smoking. This is because lung cancer predominately affects the older generation and people who have smoked; approximately 85% of cases are smoking-related.

Yet, it is crucial to also consider the 15% of people who haven't smoked and the younger generations because, as we know all too well if you have lungs, you can get lung cancer. We, therefore, have to find simple and cost-effective ways to detect lung cancer.

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**“Nearly 36,000 people die of lung cancer every year. That’s one person every 15 minutes. It’s also more than breast, cervical and bowel cancer combined, the three cancers which all have an existing NHS screening programme.”**

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We are currently funding research that looks to identify biomarkers for lung cancer including blood and sputum. If we can do that then Katie – the 34-year-old woman who endured six months of tests before being given a terminal diagnosis, Tom – the 48-year-old man who is now the third generation in his family to have incurable lung cancer and Danny – the 27-year-old dad to a beautiful little girl may have had the option of curative treatment.

Tuesday 21 November 2017 has the potential to be a hugely significant day in the future of lung cancer survival and we intend to make sure it happens.

*Roy Castle Lung Cancer Foundation is the only UK charity dedicated solely to beating the UK's biggest cancer killer. The charity has invested millions of pounds into research into the early detection of lung cancer, played a major role in the introduction of the ban on smoking in public places and has supported thousands of people living with lung cancer. ■*

### **Paula Chadwick CEO**

Roy Castle Lung Cancer Foundation  
Tel: +44 (0)333 323 7200  
[www.roycastle.org](http://www.roycastle.org)  
[www.twitter.com/Roy\\_Castle\\_Lung](https://twitter.com/Roy_Castle_Lung)

they had found a cancerous mark on my lungs. I was surprised. I hadn't been ill and had no real symptoms.

“A week later, I was admitted to hospital and had an operation. On 7th November I was given the all clear. The whole process took just two months.

“Going to the lung health MOT check was definitely the right decision. It saved my life.”

The health check also found a number of people with small nodules on their lungs. These are not currently malignant. However, they will now undergo interval CT scanning to monitor any growth or changes.

Without our health check, it is highly likely these people would have stayed under the radar and remained undiagnosed even if the nodule grew. Now, any changes would mean they should be diagnosed at a very early stage and be offered potentially curative treatment.

Whilst this is a definite step forward, it is by no means job done.

# 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](http://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](http://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%).

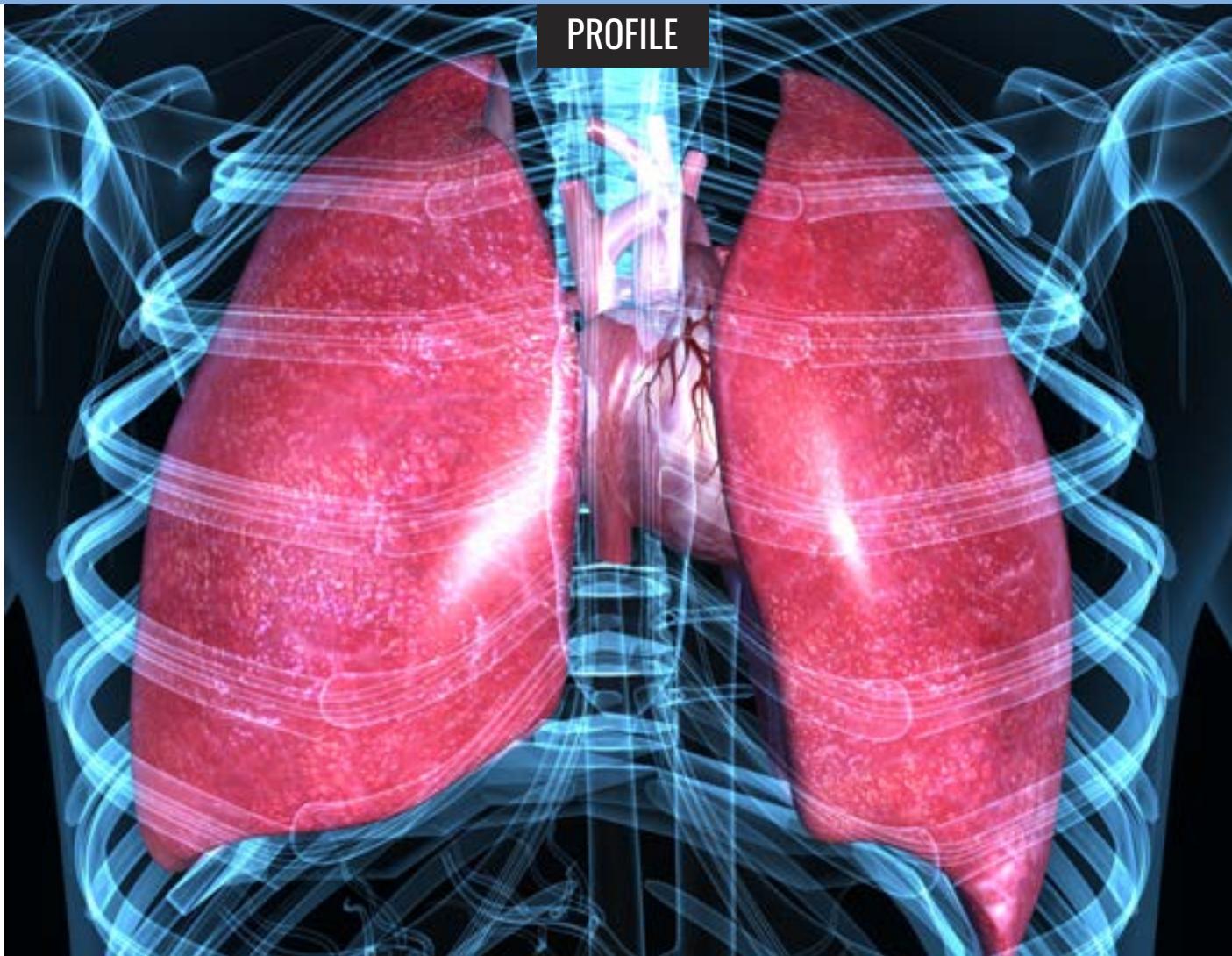
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**“One approach to dealing with heterogeneity has been to make a distinction between ARDS due to direct causes of lung injury, such as pneumonia or aspiration and ARDS due to indirect causes of lung injury, such as nonpulmonary sepsis or transfusion.”**

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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.



**Matthieu Jabaudon**  
**Associate Professor of Medicine,**  
**Anesthesiology and Critical Care**  
 CHU Clermont-Ferrand, Université Clermont  
 Auvergne, CNRS UMR 6293, INSERM  
 U1103, GReD  
 Tel: +33 473 750 476  
[mjabaudon@chu-clermontferrand.fr](mailto:mjabaudon@chu-clermontferrand.fr)  
[www.taura-project.com](http://www.taura-project.com)  
[www.gred-clermont.fr](http://www.gred-clermont.fr)  
[www.twitter.com/TAURA\\_project](https://twitter.com/TAURA_project)  
[www.twitter.com/mjOb](https://twitter.com/mjOb)



# Allergic rhinitis is scary, but health is around the corner

Roberta Savli from EFA provides insight into allergic rhinitis

**R**hinitis is a very common disorder, far more than just sneezing a couple of days in the year. Allergic rhinitis is a serious chronic respiratory disease that reduces patients' quality of life and their productivity at work and at school. Despite patients are used to cope with disease, there are things allergic patients cannot adapt to, and need political attention.

## Allergy is in the air, don't you see?

Allergic rhinitis consists of an inflammation of the nasal mucosa provoking a runny nose, and often itching and ocular symptoms. It is a disease mostly caused by viral infections or as an allergic reaction to the allergens in the air.<sup>1</sup> This brings bad news in itself because we cannot stop breathing, or see what's in the air, and the information available on the presence of airborne particles remains limited.

The current air quality monitoring legislation in Europe mainly covers air traffic pollutants and chemicals, responsible for more than 460,000 deaths in Europe every year. Indoor air pollution and biological particles, especially the allergenic aerobiological particles, are not under the radar. But if we know which allergens are in the air, we can improve diagnosis and treatment of patients with respiratory allergies.

Respiratory allergy patients, healthcare professionals and biologists have been asking the European authorities to look into the problem, develop guidelines, recommend biological pollutant levels and boost the set-up of a monitoring network in Europe.<sup>2</sup> Still, there is no general obligation to monitor and communicate about the pollen situation in Europe. Most of the 600 sampling sites for pollen monitoring in Europe rely on voluntary work, like the pollen information in Denmark, run by EFA Member Danish Asthma and Allergy Foundation.

It is not easy to explain every time what every situation, even the smallest, provokes to our health. Imagine a new built-up street decorated with allergenic trees, especially problematic if next to a school; or living in an area of open-sky industrial monoculture. Allergy concerns are intimately linked to the environment we live in, and therefore touch upon everything, even urban planning. Every time an allergenic tree is planted in urban settings it is a catastrophe for 1 in 7 Europeans living with allergic rhinitis.<sup>3</sup>

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**“In Europe, allergic rhinitis may cost up to €100 billion annually directly. Still, allergology is not a consolidated medical speciality and for that reason, patients struggle to get the expertise and guidance they need, which delays diagnosis and optimal treatment.”**

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The thinking that puts health into all policies does not come naturally in policy-making. Take for example the legislation on the energy performance of buildings directive (EPBD), under revision in the European Union. Patients see it as an opportunity not only to develop greener buildings but also healthier environments. While some Members of the European Parliament have called for better indoor air quality and the creation of a certificate to inform citizens about the air quality in closed spaces, many have not seen the link between energy and health.<sup>4</sup> As patients, we call for long, not short-sighted, vision for health.

## Research, docs and meds

Things have evolved though. It was only 50 years ago that scientists found allergic patients produce a specific antibody, immunoglobulin E (IgE), due to their sensitization to allergens, like those airborne; pollens, dust, moulds, animal dander. It was a major discovery that paved the way for new medicines and the treatments patients have today.



Image: © David Pias photographer

**Roberta Savli, Director of strategy and policy**

One of them is allergen-specific immunotherapy (AIT) for allergic rhinitis and some food allergies, which not only treats but helps to prevent and allows for a long period without medication. Regrettably, most countries consider this treatment as a last resort and therefore difficult to access, or not part of the treatment regime and not at all reimbursed, like in Belgium. Yet there is hope: 1 in 3 Members of the European Parliament have asked for more research into the causes of respiratory diseases and for reimbursed access to state-of-the-art therapy for patients. We also expect the new guidelines from the leading allergologists society, EAACI, will help to facilitate access to this secondary prevention option.<sup>5</sup>

Nevertheless, a cure for allergy remains a big question mark. There have been major European projects looking at the underlying mechanisms provoking allergy that have allowed the clustering of allergy phenotypes. This ground-breaking research will help improving diagnosis, especially when 45% of the patients are likely to be misdiagnosed in Europe.<sup>6</sup> But more needs to be done.

Allergy and asthma challenge the sustainability of our healthcare systems. In Europe, allergic rhinitis may cost up to €100 billion annually directly.<sup>7</sup> Still, allergology is not a consolidated medical speciality and for that reason, patients struggle to get the expertise and guidance they need, which delays diagnosis and optimal treatment.<sup>8</sup>

Fortunately, some countries like Finland have understood respiratory allergies as a public health problem affecting the population, and through a forward-thinking national allergy programme have invested in reducing the impact and prevent allergy with already a 5%

decrease in direct asthma and allergy costs. This is all coupled with a targeted treatment investment and support for people with severe allergy. Their motto is to endorse health, not allergy!

Unless governments start considering the investment on finding the causes of allergy and mainstreaming good allergy care as a worthy-effort, severe allergy will not go away but instead affect up to half of the population. Anyone living with someone or having severe allergy knows life is scary, but health could be just around the corner with the right support. ■

1 "About rhinitis", EAACI: <http://www.eaaci.org/patients/allergic-and-immunologic-diseases-and-causes/allergic-conditions/rhinitis/about-rhinitis.html>.

2 "Biological Air Quality Monitoring Petition", EFA-EAACI-EAS, December 2013: [http://www.efanet.org/images/2013/12/Joint\\_Biological\\_Air\\_Monitoring\\_Petition-14dec2013.pdf](http://www.efanet.org/images/2013/12/Joint_Biological_Air_Monitoring_Petition-14dec2013.pdf).

3 "Tackling the Allergy Crisis in Europe - Concerted Policy Action Needed", EAACI, June 2015: [http://www.eaaci.org/documents/EAACI\\_Advocacy\\_Manifesto.pdf](http://www.eaaci.org/documents/EAACI_Advocacy_Manifesto.pdf).

4 "Indoor Air Quality vaguely covered in the revision of the Energy Performance of Buildings directive", EFA, 9 November 2017: <http://www.efanet.org/resources/library/3249-indoor-air-quality-vaguely-covered-in-the-revision-of-the-energy-performance-of-buildings-directive>.

5 "EAACI Guidelines on Allergen Immunotherapy: Allergic rhinoconjunctivitis", EAACI, September 2017: <https://www.ncbi.nlm.nih.gov/pubmed/28940458>.

6 EAACI op cit.

7 GAL²EN, the Global Allergy and Asthma European Network.

8 "Allergy Alert! Paper", EFA-EAACI-IPCRG-ARIA-UEMS, June 2014: <http://www.efanet.org/images/2015/01/EFA-Allergy-Alert-Paper-lay-FINAL.pdf>.

### **Roberta Savli Director of strategy and policy**

EFA – European Federation of Allergy and  
Airways Diseases Patients' Associations  
Tel: +32 (0)2 227 271  
info@efanet.org  
www.efanet.org  
www.twitter.com/EFA\_Patients

# The Finnish Allergy Programme 2008-2018: Reducing the burden of allergy in both patients and society

Managing director of the Finnish Allergy, Skin and Asthma Federation, Ilkka Repo explores The Finnish Allergy Programme 2008-2018 and what it sets out to do

The Finnish Allergy Programme 2008-2018 was initiated to reduce the burden of allergy in both patients and society. The set-up of the programme was unique. The programme was developed in co-operation with the scientific community, the Finnish government and non-governmental organisations (NGO).

The key players taking part in the programme are the Ministry of Social Affairs as well as health organisations and NGOs, these being the Finnish Allergy, Skin and Asthma Federation, Organization of Respiratory Health and Finnish Lung Health Association (Filha). New scientific insights into immune development in modern, urban societies have challenged conventional thinking. The main idea was to move from allergy avoidance strategy to tolerance strategy. The programme's key messages are as follows:

- Endorse health, not allergy;
- Strengthen tolerance;
- Adopt a new attitude to allergy and avoid allergens only if mandatory;
- Recognise and treat severe allergies early; prevent exacerbations and;
- Improve air quality; stop smoking.

The programme focuses on the general population, patients with allergies and asthma, their families and public-health and patient organisations, as well as both experts and authorities. The programme consists of

two strands: the education of healthcare professionals and the information campaign to educate the public.

The Finnish Allergy, Skin and Asthma Federation coordinated the NGO's effort of informing the public about allergies and asthma in a way that they understand. The information campaign targeted 2.3 million Finnish inhabitants with little or no knowledge of the subject, out of a total population of 5.5 million. This was done through social and conventional media campaigns, lectures, articles and voluntary work.

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**"Today, we are in the final stages of the Finnish Allergy Programme 2008-2018. A leading theory behind the rising allergy and asthma diagnosis rates is the "hygiene hypothesis." This theory suggests that living conditions in much of the world might be too clean and that kids aren't being exposed to germs that train their immune systems to tell the difference between both harmless and harmful irritants."**

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Both NGOs also activated their member organisations to reach out to the public. The Finnish Allergy, Skin and Asthma Federation and the Organization of Respiratory Health consist of almost 150-member organisations and around 60,000 individual members, who between them organised a joint action to produce influential media material and campaigns to support the public awareness of asthma.

The Finnish Lung Health Association (Filha), was responsible for the education of healthcare professionals (doctors, nurses, pharmacists etc.). As a result, almost 21,000 health-care professionals have taken part in more than 300 educational sessions.



*Ilkka Repo, Managing director of the Finnish Allergy, Skin and Asthma Federation*

environment is changing. Also, the fact is that the prevalence of allergies and asthma are rising. Global warming and the destruction of species in years to come will probably affect the planet more than we can guess. We people are tied to nature from its beginning and nature is tied to us.

It is also obvious that the global trend is urbanisation. By urbanisation, we are decreasingly affected by the touch of nature. The immune system is less and less challenged by nature. Soil, dirt and dust are becoming strangers to both our bodies and immune systems. But how much this habit causes the increasing prevalence of allergies and asthma, remains to be seen.

The results of the 10-year national programme have gone through the mid-term evaluation, which certainly shows promising results. At the same time, it must be underlined that the final results are yet to be studied. The Finnish Allergy Programme 2008-2018 has and will be a truly intriguing effort, to test a paradigm and try to diminish the costs of allergy and asthma to society and individuals suffering from it. Although the results seem promising, it also must be stated that the outcome of the present real-life intervention, including all Finnish citizens, without effective controls, will also be open to criticism.

The final results of the programme will be published in 2018 by the Finnish Allergy, Skin and Asthma Federation, in cooperation with different interest groups, collaborators and scientific community. The world is changing – also within allergies and asthma. This fundamental change introduced is a global concern. To which way tide will turn, of course, wholly depends on us. ■

**Ilkka Repo**  
**Managing director**

Finnish Allergy, Skin and Asthma Federation  
[ilkka.repo@allergia.fi](mailto:ilkka.repo@allergia.fi)  
[www.allergia.fi](http://www.allergia.fi)  
[www.twitter.com/Repollkka](https://twitter.com/Repollkka)

These essential actions could not have been accomplished without dedicated voluntary work, patient NGO participation, scientific communities steering groups and external funding. The programme was financially supported by the Ministry of Social Affairs and Health. The programme also co-operated with the Finnish National Institute for Health and Welfare.

Today, we are in the final stages of the Finnish Allergy Programme 2008-2018. A leading theory behind the rising allergy and asthma diagnosis rates is the “hygiene hypothesis.” This theory suggests that living conditions in much of the world might be too clean and that kids aren’t being exposed to germs that train their immune systems to tell the difference between both harmless and harmful irritants.

Nevertheless, the fact is that the planet is changing fast. Temperatures are certain to go up further. As NASA has stated the rate of temperature increase has nearly doubled in the last 50 years. This means the



# Developing innovative therapies to treat asthma

Michael Roth from University Hospital Basel & University Basel gives a compelling overview of research into asthma and need to develop innovative therapies to treat the disease

Asthma is the most frequent common, non-communicable chronic inflammatory airway disease, which is often misdiagnosed and therefore incorrectly treated, even in industrialised countries including the European Union (2016 Symposium of the EU on the Awareness of Allergies). The costs for asthma in 2016 were estimated at €19.6 billion in the EU; the costs include therapy and loss of productivity.

**“The lack of therapies or drugs to target airway wall remodelling in asthma presents a major problem which was recognised in 2015 by the American Thoracic Society.”**

Asthma presents as a limitation of breathing capacity with reversible airflow obstruction, bronchospasm, cough, airway hyper-responsiveness, chest tightness, wheezing and chronic airway inflammation. The pathogenesis of asthma was assumed to result from chronic airway inflammation which leads to irreversible airway wall remodelling. New studies strongly suggest that both pathologies, inflammation and remodelling, occur independently, but affect each other.

Clinical studies in adults and children provided evidence that airway wall remodelling is not the result of long-lasting chronic inflammation, instead, it occurs within days after an allergen challenge in sensitive adults. In childhood asthma, airway wall remodelling



correlated with the frequency of wheezing episodes which did not show any sign of inflammation. Airway inflammation induced symptoms can be well controlled, while airway wall remodelling is resistant to all available therapies.

Despite decades of investigations, the pathogenesis of asthma is not well understood and therefore, the disease cannot be cured. In the 1920s, asthma was described as a disease characterised by increased airway smooth muscle cells and mucus accumulation in the airways. Later, immunological studies suggested that asthma is a disease caused by chronic inflammation of the airways.

Consequently, anti-inflammatory glucocorticoids were investigated and applied in asthma therapy and com-

bined with muscle relaxing drugs such as long-acting  $\beta_2$ -agonists are the most prescribed therapies for asthma. Other anti-inflammatory drugs such as phosphodiesterase inhibitors, prostaglandin E analogues and antioxidant were added to asthma therapy. However, their anti-inflammatory effects were not sufficient to replace glucocorticoids.

The development of new asthma therapies is also limited by the availability of animal models, which do not reflect all pathologies of the human disease, rather than they present either the chronic inflammation or the remodelling but not both pathologies together. The reason for this incomplete presentation of human asthma pathologies in the models may be due to the natural living conditions of the animals. Most animal models use rats

or mice, which have a different airway structure compared to humans. Taking into account that the natural habitat of these rodents is dusty and loaded with allergens makes it unlikely that they would be susceptible to develop inflammatory airway diseases such as asthma.

In the past decades, humanised antibodies to specific cytokines such as IL-3, IL-4, IL-5, IL-13 and TNF- $\alpha$ , have been developed as novel asthma therapies. However, they benefit only relative small sub-groups of patients with specific asthma phenotypes, which are difficult to identify by the available diagnostic methods. Neutralising the above-mentioned cytokines mainly benefits patients with eosinophilic asthma as demonstrated in several clinical studies; however, the contribution of eosinophils to the pathogenesis of asthma is not well understood. None of these cytokine-specific antibodies showed any effect on airway wall remodelling in humans.

One humanised monoclonal antibody application, neutralising circulating IgE, has been reported in several clinical studies to achieve lasting reduction of chronic airway inflammation in patients with allergic asthma. Neutralisation of circulating IgE in patients with allergic asthma resulted in a lasting reduction of asthma symptoms, even after the regular use of the IgE neutralising antibody was halted. It is suggested by several studies that neutralising IgE may be the only therapeutic strategy that also reduces airway wall remodelling.

However, this effect of neutralising IgE antibodies has not been proven by direct evidence in patients. There is also evidence that IgE neutralising antibodies may have unwanted side

effects, but the data on this aspect is insufficient to draw conclusions. Furthermore, some new studies indicate that neutralising IgE does not benefit all patients with allergic asthma and the nature of the allergen to which the patient response may affect the efficacy of the drug.

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**“Despite decades of investigations, the pathogenesis of asthma is not well understood and therefore, the disease cannot be cured. In the 1920s, asthma was described as a disease characterised by increased airway smooth muscle cells and mucus accumulation in the airways. Later, immunological studies suggested that asthma is a disease caused by chronic inflammation of the airways.”**

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Again, the application of humanised antibodies creates the necessity to develop new diagnostic tools enabling the classification of asthma patients. It should also be mentioned that humanised antibodies increased the costs of asthma therapy significantly. The need for more specific diagnosis of asthma phenotypes will further increase the overall costs of asthma therapy.

Recently, there is new interest in the role of vitamins in the pathogenesis of chronic inflammatory lung diseases. Vitamin C deficiency during embryogenesis and childhood has been linked with an increased susceptibility to develop chronic inflammatory lung diseases later in life. It is not proven that vitamin C supplementation during adulthood has any beneficial effect on the prevention of asthma attacks. Similar results have been described for vitamin D and the B vitamins. Scientific proof of the crucial role of vitamins as a preventive factor for chronic lung inflammation is insuf-

ficient. This lack of information may be caused by a common disbelief that the deficiency of a specific vitamin increases the susceptibility to chronic inflammatory lung diseases.

The lack of therapies or drugs to target airway wall remodelling in asthma presents a major problem which was recognised in 2015 by the American Thoracic Society. However, the pharmaceutical industry does not have any drug in their pipelines which is focused on this aspect of asthma. Instead, new glucocorticoids or other anti-inflammatory drugs are under investigations. One of the major reasons that break through could not be achieved in finding effective new therapies targeting airway remodelling in asthma is because many innovative study proposals were rejected by funding organisation with the argument of not enough supporting data. The latter is of course due to insufficient funding. If this negative cycle cannot be broken, no innovative asthma therapies can be developed.



**Michael Roth**  
**Research Group Leader,**  
**Pulmonary Cell Research**  
 University Hospital Basel & University Basel  
 Tel: +41 61 265 2227  
[Michael.roth@usb.ch](mailto:Michael.roth@usb.ch)  
<https://biomedizin.unibas.ch/nc/aboutus/people/profil/profile/person/roth-3>



# Malaria: aspirations, realities and practicalities

Dr James Tibenderana from Malaria Consortium unveils the facts about the global goal to eliminate malaria

In the past decade, the aspiration of malaria elimination has been high on the agenda. Reducing malaria deaths and the number of diagnosed malaria cases by at least 90% and eliminating it in at least 35 countries are global targets which the World Health Organization (WHO) set out in its Global Technical Strategy (GTS) for Malaria 2016-2030. These targets cannot only be the vision among development partners, they must also be the promise we make to the populations at risk of malaria – close to half of the world's population.

Along the continuum to malaria elimination, in certain settings reduction in malaria transmission is possible with existing tools and it is important that what has been achieved so far is maintained. Receptivity to malaria transmission in such settings should be reduced at the same pace as the number of malaria cases and deaths.

However, in other settings with very high malaria transmission, where tools are reducing malaria cases and deaths, on their own, they are unlikely to decrease receptivity and cannot, therefore, guarantee the disease's decline. In fact, with existing products starting to show signs of decreasing effectiveness due to factors such as insecticide and drug resistance, the need for improved and new tools is critical.

Some examples of new tools are insecticides for indoor residual spraying and long-lasting insecticidal nets containing the synergist piperonyl butoxide, which heightens the effect of the insecticide, new antimalarials such as tafenoquine, the RTS,S malaria vaccine and genetically modified mosquitoes. These products take time to go through different stages of development and introduction and continued investment in research and development is fundamental to maintain a healthy flow of new tools.

The cost of new effective tools is likely to be more expensive relative to those that already exist, at least in the early stages. This could lead to a trade-off between less coverage for more effective (and expensive) tools if existing funding levels for malaria elimination are maintained. This means that with the same level of investment the introduction of new tools will lead to a decline in their coverage. WHO estimates that for the first milestone of the GTS – a reduction of at least 40% in malaria case incidence and mortality rates globally compared to 2015 levels – \$6.5 billion is required each year. Yet in 2016 the funding investment in malaria was \$2.7 billion, which is less than half of what is needed.

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**“Whereas all efforts should be made to increase access to and use of all current tools, more effective targeting will be achieved if all suspected cases of malaria are tested and data on malaria are collected reliably and used for decision-making. We need to ‘Think globally, act locally’.”**

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So, will global investment in malaria elimination really double in the short term? From a pragmatic point of view, this seems unlikely if spending on health solely occurs through development assistance. Mixed models of financing which combine overseas development assistance, government spending, out-of-pocket expenditure by individuals to health care providers, health insurance and public-private partnerships present other opportunities for increased investment. In any case, the improved targeting of existing and new tools when and where they are needed most will be essential to reverse the recent upward trend in the number malaria cases outlined in the World Malaria Report 2017.

This report states that the target requiring urgent and immediate attention is ‘mortality reduction’. This is illustrated by the following contradiction: while the number of malaria rapid diagnostic tests (mRDTs) distributed by national malaria programmes (for the public sector) reduced from 312 million in 2015 to 269 million in 2016, the number of antimalarial drugs (artemisinin-based combination therapies or ACTs) increased from 311 million in 2015 to 409 million in 2016. This reminds me of when mRDTs were first introduced in Uganda and neither health workers nor patients believed a negative result, as they felt certain

all fevers required malaria treatment. Health workers continued to give patients ACTs regardless until the Ministry of Health and other stakeholders were able to improve confidence in the test results.

Quality-assured case management for both uncomplicated and severe malaria through the public and private health sectors requires attention. The focus should be on improved management of febrile illness through the availability of treatment options for the common causes of fever. This will help to optimise the diagnosis and treatment of malaria. Examples of such options are community-based primary health care and facility-based primary health care with differential fever diagnosis and treatment (in secondary or tertiary level health facilities). When parasite-based diagnosis through microscopy and mRDTs is universally practised (in both public and private sectors) and of high quality, the data recorded into the routine health management information and surveillance systems will be more useful.

To this effect, having an annual World Malaria Report is essential. Data-driven decision making is even more critical at all levels of the health system. Whereas all efforts should be made to increase access to and use of all current tools, more effective targeting will be achieved if all suspected cases of malaria are tested and data on malaria are collected reliably and used for decision-making. We need to ‘Think globally, act locally’. ■



**Dr James Tibenderana**  
**Global Technical Director**

Malaria Consortium

Tel: +44 (0)20 7549 0210

[info@malariaconsortium.org](mailto:info@malariaconsortium.org)

[www.malariaconsortium.org](http://www.malariaconsortium.org)

[@jktibenderana](https://twitter.com/jktibenderana)

[@FightingMalaria](https://twitter.com/FightingMalaria)



# For malaria progress: The bottom line IS the bottom line

David H Peyton, Ph.D., Professor of Chemistry at Portland State University explores the progress being made on malaria in the world today

The annual report issued by the World Health Organization (WHO) that tracks malaria worldwide came out at the end of November 2017 and it was not reassuring to those of us working against malaria. This report gave a picture that indicated progress has stalled (a word taken from WHO's website). This is a sobering introduction to the report, especially for an organisation that has been, in this person's estimation, optimistic about the state of malaria over the last few years.

**"New data from national surveillance systems suggests that we may be underestimating the burden of malaria and WHO will embark on a detailed review of national data and estimation methods in 2018. Even with the current conservative estimates, however, globally, the fight against malaria is at a crossroads."**

*(From the World Malaria Report 2017, page 61)*

## What has stalled in malaria control?

To answer this, I turn to the Malaria Report itself. Firstly, the number of cases of malaria has increased, as enumerated in the report. This metric is greatly important because it reflects not only deaths, but also other burdens on the local economies, as well as effects on families, health systems and so on. Not only is the relatively modest increase in this number important – especially because the number has not



decreased – but it is admitted being a conservative estimate by the compilers of the report.

Thus, the situation may be worse. These numbers are also somewhat biased in earlier years by the introduction of more rapid diagnostic tests for malaria, that has allowed more accurate numbers – rather than just presumption from a fever presentation: it may be that some of the earlier years' declines in malaria cases are not entirely accurate.

Secondly, the number of deaths from malaria has remained constant from 2015, instead of decreasing. Given the increase of cases, this might be taken as a minor victory, but remember – these numbers are conservative,

so caution would be advised in any celebration.

Thirdly, the rate of distribution of insecticide-treated nets (ITNs) has decreased since 2014. This is particularly disturbing because the nets are not durable and holes in them can be viewed as analogous to drug resistance. If a mosquito can fly through a little hole, the net may reduce the frequency of biting, but still not (eventually) prevent the transmission of malaria.

The distribution of ITNs is primarily to those who are 'underserved' (have no nets, or not enough nets), so those with nets that are damaged or have an insecticide that has worn off or expired need net replacements. Yet the accounting for these cases is not clear.



Also, the mosquitos are becoming more resistant to the most common insecticides on the nets.

Fourthly, the intermittent preventative treatment of pregnant women (IPTp) is still far below the rates hoped for by the policy-makers. The same can be said for IPT of children.

Fifthly, access to appropriate drugs has improved over the last seven years, as has the application of rapid diagnostic testing. Yet even here, the overall coverage remains uneven, with some countries still not providing good access. Counterfeit drugs also remain a problem, especially in the private markets.

## What is at the heart of the lack of progress that we are seeing?

We must look to the budgets, as much as we might wish to think that problems might be solved elsewhere. Realistically, problems like malaria, having

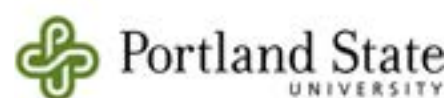
a global reach and demanding both technological and implementation aspects to solve them over decades, must have sufficient funding to have any chance at success.

The World Malaria Report 2017 provides graphs on page five – demonstrating that the funding for the entire malaria enterprise has remained at about \$2.8 billion (\$2016-U.S., from 2010 – 2016). In fact, 2013 was the high-funding year (about \$3 billion), followed by 2010 & 2012 (which had nearly the same funding amounts).

So, this is the situation that WHO optimistically terms, “stable.” The major amount of funding comes from the U.S., yet the future of support from the U.S. for international projects may not be stable. For example, in 2017 an early draft budget from the President did not provide for the continuation of the Fogarty International Center of the National Institutes of Health and a

large tax ‘restructure’ (cut) has just been enacted by Congress.

The message of the World Malaria Report is clear – that the financial underpinning for malaria needs to increase substantially – but whether this will be a realistic expectation from the U.S. and other sources is quite another matter.



**David H Peyton. Ph.D.**  
**Professor of Chemistry**  
 Portland State University  
 Tel: +1 503 725 3875  
[peytond@pdx.edu](mailto:peytond@pdx.edu)  
[www.pdx.edu/chemistry/profile/dr-david-h-peyton](http://www.pdx.edu/chemistry/profile/dr-david-h-peyton)  
[www.twitter.com/dmi\\_doc](https://twitter.com/dmi_doc)

# Technology interventions to address dyspnoea: Point-of-care lung ultrasonography

Cecilia Van Cauwenberghe from Frost & Sullivan's TechVision Group highlights technology interventions that address dyspnoea – focussing on point-of-care lung ultrasonography

The Murray and Nadel's Textbook of Respiratory Medicine (Schwartzstein and Adams, 2016), etymologically defines dyspnoea from the Greek dys (painful, difficult) and pneuma (breath). Clinically, dyspnoea constitutes a medical expression related to the awareness of breathlessness or shortness of breath experienced by both normal subjects and patients suffering, from either respiratory or cardiovascular disease, such as chronic obstructive pulmonary disease (COPD), heart failure, advanced cancer and interstitial lung diseases, among many others.

It is important to remark that breathlessness or dyspnoea is generally defined subjectively (Bolzani et al., 2017a). The experience of breathing discomfort involves qualitatively individual perceptions that may vary in intensity. Just to make a small but important difference, breathlessness indicates the patient's perspective according to daily experience; dyspnoea applies to the vital signs of the underlying medical condition. Such a patient's perspective or experience also entails interactions among multiple physiological, psychological, social and environmental factors, intervening all together in the form of a secondary physiological and behavioural response.

Due to its causes may derive from multiple sources, no precise data on the prevalence of dyspnea is available (Bolzani et al., 2017b). Meta-analyses insinuate a worldwide prevalence of 10% for COPD in adults older than 40 years exhibiting dyspnea as a cardinal symptom. Dyspnea in children, on the other hand, has been reported including its psychosocial impact (Lands, 2017).

Such a subjectivity of dyspnoea is precisely one of the main challenges faced in both diagnosis and treatment. Its causes fall into three broad categories: respiratory

system dyspnea, cardiovascular system dyspnea and dyspnea due to atypical causes. Moreover, different types of dyspnea can be cited according to its duration: acute (sudden appearance and persistence over hours to days) and chronic (gradual appearance and persistence during weeks or months).

Different types of dyspnea are also observed in terms of activity: physical exertion dyspnea (unpredicted dyspnea at rest indicating a potentially serious medical disorder), intermittent dyspnea (usually due to cold air or allergy suggesting asthma), work-related dyspnea (potentially indicating occupational asthma), upper respiratory tract infections dyspnea (suggesting COPD), orthopnoea (when lying down, usually in the supine position, typically associated with heart failure), paroxysmal nocturnal dyspnea (also indicating heart failure), trepopnoea (associating shortness of breath with lying on the left or right side) and platypnoea (only in the upright position), among other types.

Therefore, determining the cause of dyspnea is a task of vital importance in which first symptoms appearance, onset, character, duration, interval, periodicity and acuteness of the symptoms play all distinctive roles.

## Clinical interventions of dyspnoea

### Primary assessment

Primary assessment starts with a physical examination. Hence, when receiving a case of dyspnea, important clues about its underlying causes can be provided by assessing vital signs. Tachycardia or accelerated pulse, for instance, may indicate anemia, heart failure, or pulmonary embolism. Peripheral edema or distention of the jugular veins may be also associated with heart failure, as well as, cardiac whispers may be related to cardiac valvular disorders. Conversely, decreased breath sounds and wheeziness may suggest COPD.



Conventional testing implies pulse oximetry, complete blood count, basic metabolic panel, chest radiography, electrocardiography (ECG) and spirometric studies, which either reveal or discharge the existence of signs of heart failure, arrhythmias, pneumonia and interstitial lung disease or lung tumour. Evidence of asthma and pulmonary embolism may exhibit normal radiographic findings; however, spirometry is a supportive study for detecting airflow obstruction. Additional studies comprise echocardiography, computed tomography (CT scan), ventilation-perfusion scanning, ultrasound and stress testing.

Primary measures in blood analysis may involve brain natriuretic peptide (BNP), a cardiac neurohormone secreted by the myocardium and its prohormone, N-terminal pro-BNP, which in patients with dyspnoea due to heart failure, their concentrations are increased, thus helping physicians to discern between respiratory and cardiovascular causes of dyspnoea. Another biomarker frequently used is D-dimer, associated with fibrin degradation in the blood and pulmonary emboli.

### **Multidimensional diagnostics approaches**

Dyspnoea can be defined as a multidimensional experience. Therefore, there is no a comprehensive, validated instrument capable of embodying the multidimensional nature of dyspnoea (Banzett and Moosavi, 2017). Now, there are two multidimensional instruments: the Dyspnoea 12 (D-12) and the Multidimensional Dyspnea Profile (MDP) intended to address this challenge.

D-12 was designed to provide a single global score embracing the affective dimension. This approach is easy to apply to a variety of patient groups and accessible for patients waiting to be seen in a clinic. It attempts to avoid under- or over-medication based on unidimensional scales that ignored the affective aspect of dyspnoea.

MDP was elaborated to deliver a better characterisation of the complex dyspnoea experience, also matching laboratory and clinical. Patients first of all, rate the overall breathing as a scale indicator of discomfort or



unpleasantness and then rate the intensity of a set of individual sensory descriptors. The approach also comprehends a measurement model for pain and a list of negative emotions, in addition to the synonymous sensory descriptors and sensation categories for clustering and principal components analyses.

### Breathlessness management

Suitable management to relieve breathlessness in advanced diseases may require both pharmacological and non-pharmacological interventions (Bolzani et al., 2017c). Some pharmacological interventions refer to opioids, benzodiazepines and oxygen. Nevertheless, the use of drugs to treat breathlessness, especially if the underlying cause is not deeply understood, is limited due to potential adverse side effects and the extreme care needed for doses titration.

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Non-pharmacological interventions for the relief of breathlessness may be focused on three categories: respiratory, related to inefficient breathing observed due to dysfunctional breathing patterns and increased respiratory rate; cognitive-emotional, associated with patient feelings around the sensation of breathlessness generating anxiety, distress, feelings of panic and thoughts about dying; and physical, related to deconditioning of limb, chest wall and accessory muscles as a result of dyspnoea.

Non-pharmacological interventions focused on respiratory approaches attempt to relieve breathlessness through breathing training, handheld fan and chest wall vibration, among many other resources (Bolzani et al., 2017a). Non-pharmacological interventions concentrated on cognition or emotion to relieve breathlessness use distractive auditory stimuli (music), meditation/relaxation (e.g. visual or guided imagery; progressive muscle relaxation), biofeedback, mindful-

ness-based stress reduction, yoga therapy and psychological therapy (e.g. cognitive behavioural therapy) (Bolzani et al., 2017b). Non-pharmacological interventions based on physical functioning may involve pulmonary rehabilitation and nutrition support (Bolzani et al., 2017c).

### Technology interventions of dyspnoea

#### Point-of-care lung ultrasonography

The influence of age, multimorbidity, cognitive and motor impairment is essential for the accurate diagnosis of dyspnea (Vizioli et al., 2017). In fact, lung ultrasound (LUS) has been widely recognised as a relevant study in the differential diagnosis of dyspnea in internal medicine (Perrone et al., 2017). Being dyspnoea one of the most recurrent causes of admission in internal medicine wards (Wang et al., 2017), LUS at the bedside provides high sensitivity and specificity, thus helping clinicians to manage medical resources. In fact, a wider use of a portable technique in the internal medicine wards is significantly gaining attention. Bedside LUS has demonstrated to notable contributions to the differential diagnosis of dyspnoea, exhibiting higher sensitivity and specificity than any other technique. Its application not only is restricted to emergency rooms, but also to sub-acute internal medicine areas.

Radiologic and laboratory results may cause disproportionate delay previously adequate therapy is indicated. Therefore, the use of an integrated point-of-care ultrasonography (PoCUS) approach may represent the ideal solution by offering shorter time needed to formulate a diagnosis, while preserving an appropriate safety profile (Zanobetti et al., 2017).

This non-invasive intervention may involve the ultrasound evaluation of the lung, heart and inferior vena cava, in addition to conventional tests, which can be performed in parallel.

PoCUS has shown results for the diagnosis of acute coronary syndrome (ACS), pneumonia, pleural effusion, pericardial effusion, pneumothorax and additional causes of dyspnea, with remarkable accuracy when compared to conventional examinations. Indeed, PoCUS may result significantly more sensitive, especially when the cause of dyspnea is associated with heart failure.

Furthermore, patients can be stratified for a more detailed assessment, in which PoCUS denotes a feasible and reliable diagnostic approach to the patient with dyspnea, additionally involving a considerable reduction in time to diagnosis. In agreement with these approaches, adjacent technologies such as wearables, microfluidics, emerging sensors and artificial intelligence, are converging toward the development of new products focused on the complexity around dyspnoea.

## Brief market landscape considerations

According to Frost & Sullivan investigations (Das, 2016), point-of-care testing (POCT) constitutes an integral part of the healthcare market. Indeed, POCT is promptly evolving into a preferred testing mode in Europe and North America. Frost & Sullivan found that POCT, a particularly PoCUS, displays unparalleled growth opportunities for a cross-section of players, ranging from original equipment manufacturers (OEMs) to data integrators to technology vendors.

The stakeholders need to be well-informed about the challenges posed by the industry to design intelligent growth strategies - to innovate their business models and capitalise on the transformation that the market is undergoing and principally, to deliver real-world solutions to unmet medical needs such as dyspnoea. Different technological building blocks are smartly contributing to the better clinical translation and functionality of powerful tools to diagnose dyspnoea. ■

### Acknowledgements

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**Cecilia Van Cauwenberghe, Ph.D., MSc, BA**  
**Associate fellow and senior industry analyst**

TechVision Group, Frost & Sullivan

Tel: +1 210 678 3623

[Cecilia.VanCauwenberghe@frost.com](mailto:Cecilia.VanCauwenberghe@frost.com)

[www.frost.com](http://www.frost.com)

[www.twitter.com/Frost\\_Sullivan](https://twitter.com/Frost_Sullivan)

# 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.<sup>1</sup> 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.<sup>2</sup> 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.<sup>3</sup>

Frequently, the large veins of the antecubital fossa are sufficient to place large bore peripheral IVs needed for resuscitation. The brachial and basilic

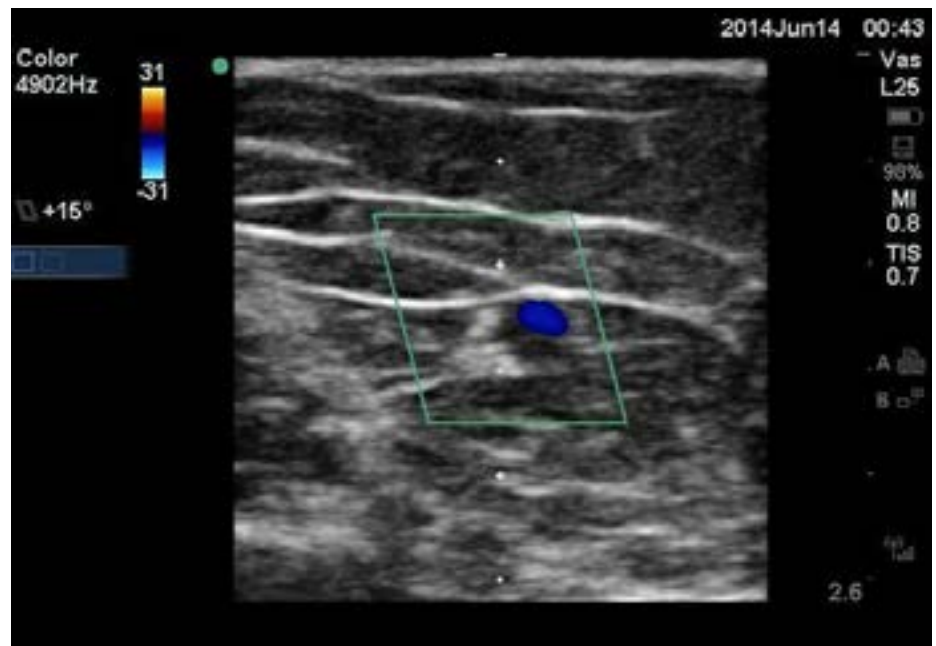
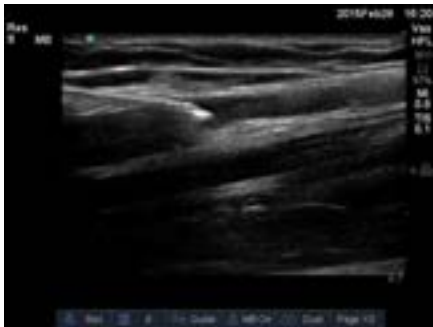


Figure 1: Short axis view of a peripheral vessel visualised with Colour Doppler (blue). The scale on the right of the screen demonstrates a total depth of 2.6 cm. A guide (white dots) in the centre of the screen marks each 0.5cm of depth. Therefore the depth of the vessel is between 1-1.5cm deep to the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

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 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 angi catheters may be required for cannulation.

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 an '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 angi catheter 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.

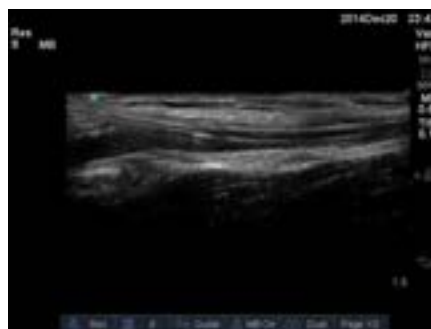
## Identify the vein: remember the two C's

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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**Virginia M Stewart, MD**  
 Forsythe Emergency Services, PA  
 PO Box 25447  
 Winston-Salem  
 NC27114  
[askdrstewart@gmail.com](mailto:askdrstewart@gmail.com)  
[www.fespagroup.com](http://www.fespagroup.com)



# Increasing the quality of higher education and research

**Torbjørn Røe Isaksen, former Minister of Education and Research reveals his ambitions to increase the quality of higher education and research in Norway**

These are interesting times for education, research and innovation policy. Policy development is taking place against a backdrop of an increasingly volatile world, with climate change, an ageing population, rising populism and an abundance of “fake news”, even “fake science”. Research and innovation are essential if we are going to respond to such challenges successfully.

Furthermore, technology shifts have taken us to the brink of a revolution in the labour market. We do not know how far-reaching it will be, but there seems to be a consensus that digitalisation and automation will not just make certain blue-collar jobs obsolete, but also highly skilled jobs.

Rapid technological developments mean that we also need our higher education institutions to take a leading role in shaping tomorrow's workforce. What can they do to ensure that students not only graduate with skills that are in demand in today's labour market, but also have the ability to adapt and renew their knowledge and skills?

In Norway, we have been lucky for a long time. The oil and gas sector has been an engine of economic growth. The importance of oil and gas, the seas and the oceans is still there, but now the mainland economy is moving more centre stage, as is already the case in most of the rest of Europe.

We know that a shift of the Norwegian economy is necessary if we are to remain prosperous in the future. Research, innovation and education are becoming even more important if we are going to make this transition successfully.

I would like to highlight four policy initiatives taken by the government to increase quality in higher education and research.

Image: © Marte Garmann



**Torbjørn Røe Isaksen, former Minister of Education and Research**

Norway is a small country in terms of population, but covers a large area. That is why the national structure contains a relatively high number of higher education institutions. Since 2015, we have taken initiatives to merge institutions and build stronger national networks in various fields of higher education and research. Several university colleges and universities have merged in order to ensure strong institutions and excellent academic networks.

We need to have greater ambitions on behalf of our students. Last year we presented a white paper on quality in higher education. We aim to stimulate the development of quality within all educational programmes, as well as particular measures to stimulate the most talented and motivated students.

Excellent teaching should not depend on a few individual enthusiasts, while status and resources are rewarded primarily to the foremost researchers. Rather,



educational quality must be the responsibility of the academic community as a whole.

Firstly, we require universities to develop systems for recognising good teachers and promoting their academic careers. Secondly, academic programmes will be subject to peer review to a much greater degree than today. Thirdly, we will set up a national arena through which educational communities can compete for resources to develop good teaching.

The white paper is a clear invitation to universities to take a leading role. What can they do to ensure that students not only graduate with skills that are in demand in today's labour market, but also have the ability to adapt and renew themselves?

The government presented the long-term plan for research and higher education in 2014. The plan will be revised every four years. We are currently working on the first revision.

The long-term plan is the most important tool for ensuring satisfactory coordination and implementation of policy on research and higher education. The plan has been a success. The government allocated 2,9 billion NOK in the follow-up of the plan. Taking the 2018 budget into account, we reached all the goals we set out in 2014.

Education is the key to maintaining high employment rates and a productive and innovative workforce. However, it is also the key to develop and refine a democratic culture.

In 2017 we presented a white paper where one of our primary objectives is to present measures to ensure that the humanities engage with today's grand challenges to a greater degree. I believe that both the humanities and the social sciences must play a central role if we are going to overcome the most pressing challenges of our time. ■

On Wednesday 17th January 2018, Torbjørn Røe Isaksen was appointed as Norway's Minister of Trade. Mrs Iselin Nybø is now the Minister of Research and Higher Education in Norway. However, both ministers belong to the same government, so the broad policies Mr. Røe Isaksen outlined in this article are still relevant.

### **Torbjørn Røe Isaksen**

#### **Former Minister of Education and Research, Norway**

Ministry of Education and Research

Tel: +47 22 24 74 00

[postmottak@kd.dep.no](mailto:postmottak@kd.dep.no)

[www.regjeringen.no/no/dep/kd/org/Kunnskapsminister-Torbjorn-Roe-Isaksen/id742623/](http://www.regjeringen.no/no/dep/kd/org/Kunnskapsminister-Torbjorn-Roe-Isaksen/id742623/)

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# Promoting research, science and innovation in Europe

The work of European Commissioner for Research, Science and Innovation, Carlos Moedas is placed under the spotlight by Open Access Government

European Commissioner for Research, Science and Innovation, Carlos Moedas was previously Secretary of the State to the Prime Minister of Portugal. One of Moedas's main priorities today is social innovation – a topic which he spoke about at a conference in Portugal on November 27th, 2017.

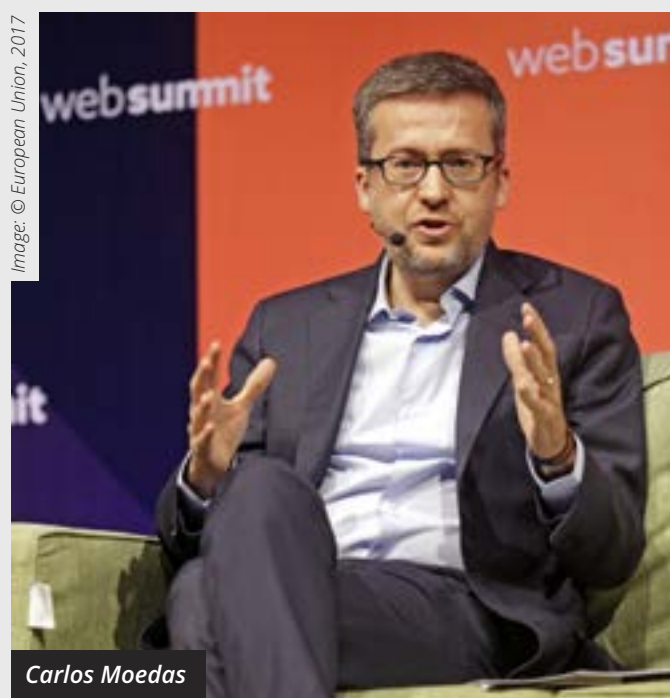
Moedas described the conference as a milestone, rather than simply an event. It marks the new era of social innovation in Europe, with Portugal becoming a world leader. "Just take a look at your conference welcome bags today. Inside you will find a colour code developed specifically for colour-blind people. And this was developed by a social innovation company, ColourADD, based in Porto", he says.<sup>1</sup>

**"Media and Artificial Intelligence (AI) may seem like polar-opposite areas of concern, yet both are so relevant to all the European Commission – not just in professional lives as policy-makers who are focused on science and technology – but also as consumers of media."**

The Commissioner clearly outlines the origins of his recent push for this conference, after having a conversation with European Commission President, Jean-Claude Juncker. Juncker tells Moedas that he would like to stress the importance of the social aspect of innovation to the European Commission and to the future of Europe. From then on, they established a strong and passionate team to help make the conference a reality. "Social innovation is about two things: sense of purpose and reducing inequality", Moedas went on to say.<sup>1</sup>

Moedas goes on to state that welcoming innovators with new ideas is not enough for a progressive future. It is also extremely necessary to actively find innovative ways to encourage social innovation. One way in which

Image: © European Union, 2017



Carlos Moedas

they will do this and was announced by Moedas at the 'Opening up to an era of Social Innovation' conference is the official launch the Horizon Prize for Social Innovation. With this prize, they hope to tackle one of the most pressing challenges of our ageing society: mobility.

With an ageing population of an expected 88 million elderly European citizens predicted by 2030, it is obvious that action should be taken to accommodate this change. The challenge to participants is this: they must be able to develop and test an innovative solution for safe and sustainable movement for the elderly. The winner will receive €1 million and each of the four runners-up will receive €250,000.

Here, Modeas is constantly evaluating how research can be maximised and enabling cooperation across multiple sectors with other European commissioners. The official responsibilities of his position are as follows:

- Ensuring that research funding programmes, notably Horizon 2020, contribute to the European Commission's jobs, growth and investment package;
- Promoting the international excellence of the EU's research and science and strengthening research capacities and innovation across all member states;
- Evaluating how EU-funded research can be used more effectively;
- Ensuring that European Commission proposals are based on scientific evidence and;
- Encouraging private companies to apply research to meet challenges faced by society and creating more high-quality jobs.

Just one week prior to the conference on social innovation, Moedas (who labels himself a techno-optimist) also spoke about 'Media in the Age of Artificial Intelligence', at the STOA Annual Lecture. He addresses recent challenges faced by society in areas of science.

Media and Artificial Intelligence (AI) may seem like polar-opposite areas of concern, yet both are so relevant to all the European Commission – not just in professional lives as policy-makers who are focused on science and technology – but also as consumers of media.

He perfectly highlights the link between the two, as today's society infiltrates every part of our lives, for example letting it shape our ideas. He also goes on to say: "Because many of us start our day in work by consulting the media. We might read the politico playbook or scroll through social media on our commute to work."<sup>2</sup>

At the STOA Annual Lecture: 'Media in the Age of Artificial Intelligence', we find out that the media plays such a big role in our lives and in decision-making, both for people in their personal lives and for governments. If complex, sometimes scientific debates are distorted in the media, intentionally or not, this can have immeasurable effects on our lives and the lives of our families for years to come, indeed we learn that fearmongering spreads.

Moedas then stresses the importance of truth in the media surrounded science and talks through of a series of steps that can be taken to avoid this. This can be summarised as follows:

- Explaining the process of science;
- Creating places of trust;
- Being tougher on research integrity;
- Tackling fake news head-on. (Recently, the European Commission announced the launch of a new high-level expert group and public consultation on fake news and online disinformation. With this, the aim is to get a grasp of this phenomenon and formulate recommendations to combat it.)

At the STOA Annual Lecture: Media in the Age of Artificial Intelligence, Moedas explains: "Artificial intelligence is not a threat. How we choose to use it is. And I think that fearing what is arguably one of the most exciting new technologies of our generation and denying ourselves its amazing benefits is not the answer."<sup>2</sup>

Moedas certainly prioritises openness in science, as he believes that this is the way forward to achieving effective and efficient innovation. Collaboration, international mobility, support and research and embracing potential are all driving forces in Moedas' work and indeed more widely, the European Commission's. ■

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# Nanomaterials in the semiconductor industry: An end-user industrial perspective

Dr. Dimiter Prodanov from Imec gives an end-user industrial perspective on the vital role of nanomaterials in today's semiconductor industry and their safe use

**N**anomaterials are broadly defined as those materials that have a certain percentage of particles at the nanoscale, between 1 and 100 nanometres<sup>1</sup>. While the size cut-off used in the definitions is somewhat arbitrary, it nevertheless conveys the important fact that properties of materials with nanoscale features (e.g. nanoforms) can substantially differ from the properties of "macro" materials in bulk.

Nanoforms can have desirable characteristics, such as the increased strength of the material, modified chemical reactivity or electrical properties. These features offer possibilities for new applications in a broad range of sectors; for example, in medicine (e.g. detection of genetic sequences using DNA-tagged gold nanoparticles); environment (e.g. waste-water treatment with carbon nanotube filters); or energy production (e.g. solar cells using silicon nanocrystals).

At the same time, the use of manufactured nanomaterials in various commercial applications raises questions about potential unintended risks to both humans and the environment: for it is known that particles of nanometre size can get deposited in the lungs, pass easily through alveoli or even get dispersed in the body.

## Top-down and bottom-up approaches to nanotechnology

Nanotechnology intentionally uses desirable properties of materials at the nanoscale to deliver economically beneficial effects. From a technological perspective, there are two complementary approaches: top-down and bottom-up processing. While the bottom-up approach can be broadly identified as particle synthesis or self-assembly, the top-down approach can be thought of as growth or deposition on surfaces. An example of the latter can be found in the micro- or nano-electronics industry. Nanomaterial

manufacturers typically employ bottom-up approaches, while end-user industries incorporate engineered nanomaterials into macroscopic objects, for example in products like computer chips, tires and sportswear.

From an industrial end-user perspective, modern nanoelectronics employs technologies offering unprecedented control of the properties of the finished product in large volumes. Semiconductor processing today uses a variety of materials, as companies seek to further improve devices' performance to meet an increasing market demand.

This innovation, in turn, leads to some new materials and nanoforms being introduced in process technology. Typically, the product development runs ahead of the establishment of metrics for the occupational and environmental hazards related to these materials. Since nanoelectronics inherently deals with novel materials and processes, the challenge is the lack of information leading to uncertainty in risk grouping and governance.

Other industries are facing similar concerns due to the development of new materials; for example, the pharmaceutical and the cosmetics industries, although on longer time frames. While there is no golden standard for risk assessment and management, several pragmatic systems have come into being. All these approaches



Consortium meeting in Cork, Ireland, 15th Sept 2016

implement the precautionary principle as a way of avoiding underestimation of the risk.

## International efforts and EU regulations

Understanding the properties of engineered nano-materials and how they behave in living systems, such as the human body, is a relatively new area of scientific study. It becomes increasingly clear that harmful properties of nanoforms sometimes do not correlate with the toxicological profile of the bulk materials. One of the challenges in that respect is the identification of the best metric for toxicological assessment. A related challenge is how to define a 'nanomaterial'.

To address these challenges international bodies, such as the European Union, have orchestrated substantial efforts. As part of this ongoing effort, the European Commission funds the **NanoStreeM** project. The NanoStreeM project is funded under H2020 grant agreement 688194 of the European Commission. The goals of the project are to promote good practices by identifying applicable standards – and to identify gaps in methodologies and directions for further investigations to support governance of the occupational risk induced using nanomaterials in the semiconductor industry.

## Vision

A holistic view of the nano-hazard and the related process risk is crucial for successful integration of nanosafety aspects into the overall risk management methodology. Material properties, health effects, the potential of release and occupational exposure are principal aspects for successful risk mitigation (see Figure 1). The **NanoStreeM** consortium combines unique expertise throughout the



*Figure 1. Management of nano-risk in the semiconductor industry*

research and development chain: from the academic labs via technology development through the semiconductor application side.

The consortium partners set forth the following objectives:

- Build inventories of materials, research topics and directions relevant for nanomaterial use and exposure in nanoelectronics manufacturing.

Activities grouped along this direction will allow the semiconductor industry to get further insight in emerging risks and continue taking a pro-active approach in the control of risks of using engineered nanoparticles and in the potential release of incidentally generated nanomaterials. This direction also identifies the specific novel engineered nanomaterials, which may be introduced in the future; for example, rare earth elements, transitional metal nanowires, carbon nanotubes or graphene.

- Identify gaps in knowledge and methodologies to assess the risk of engineered nanomaterials used in semiconductor manufacturing or

incidentally released as by-products of the manufacturing process.

Activities along this direction aim to identify suitable risk assessment tools developed in the context of other industries or funded projects. The identification of commonly missing information about physical, chemical or toxicological properties of the materials in scope may be the input for further studies in the growing field of nanosafety. Another important outcome will be the comparison of current practices of medical supervision with respect to occupational exposure to engineered nanomaterials.

- Apply results for better governance of the emerging risks.

We identify safety training as a crucial aspect of prevention of accidents and exposure. To this end, the consortium develops a generic Nanosafety training package applicable to the semiconductor industry. This is an outcome, which can allow a lasting impact beyond the duration of the project. More information is available on the project website at [www.nanostreem.eu](http://www.nanostreem.eu).

1 EC definition: at least 50% primary particle threshold, except in specific cases.



**Dr. Dimiter Prodanov MD, PhD**  
**EHS Life Science Partner**

Imec

Tel: +32 162 818 40

[dimiter.prodanov@imec.be](mailto:dimiter.prodanov@imec.be)

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

[www.twitter.com/nanostreem](https://twitter.com/nanostreem)

# Moving towards clinical applications of genomics (The TrainMALTA project)

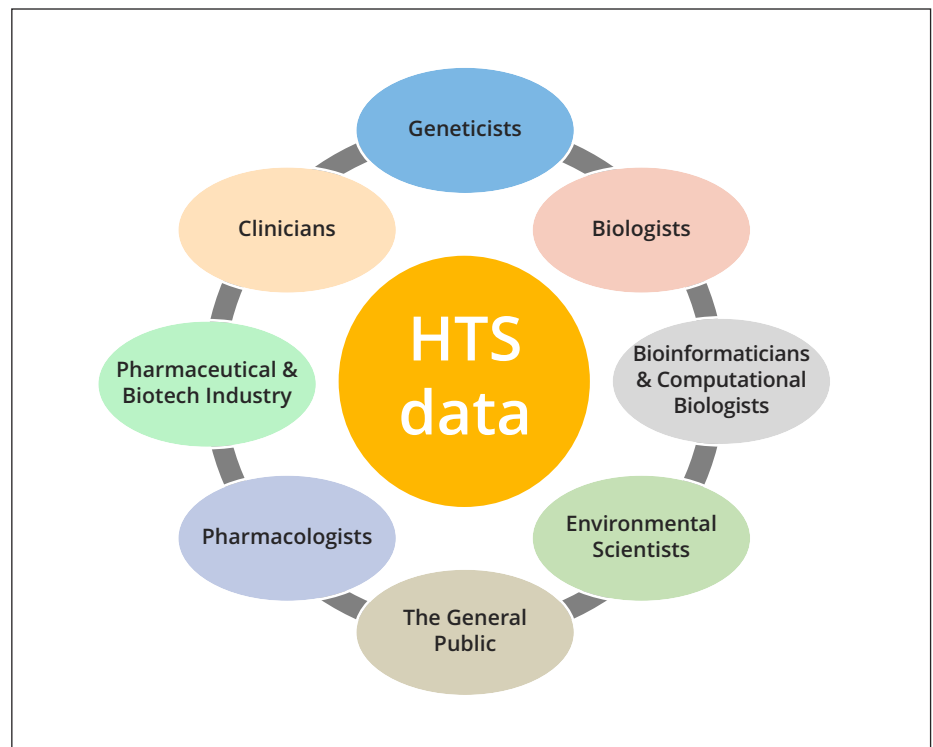
Rosienne Farrugia from the University of Malta explores the role of high throughput sequencing (HTS) in rare and complex diseases, including the move towards the clinical applications of genomics

**H**igh throughput sequencing (HTS) is poised to play an ever increasingly central role in the elucidation of the causes of both rare and complex diseases. Technology developments in recent years have revolutionised the approach to genetic studies making it possible to query the entire genomic sequence, detecting most variants within the genome. The same technology is also applicable to epigenomic and transcriptomic research, making possible the generation of multiple layers of high throughput data from a single sample. This data can be integrated together to give a more complete picture of gene function.

**“A wide range of bioinformatics techniques and software tools are available today, enabling researchers to draw new insights from biological datasets.”**

HTS has changed the way genetics and molecular biology research is carried out. In the very near future, HTS will also find widespread application in the clinical diagnostics of Mendelian disorders, greatly improving on the 20% diagnostic sensitivity of the current Sanger candidate gene approach.

With the emerging gene-specific and mutation-specific therapies, HTS will in time supplant even other non-molecular diagnostic tests. This technology enables scientists to sequence entire



genomes, generate RNA profiles and investigate genome-wide epigenetic changes at an increasingly fast rate and low cost. Technological advances have made it possible to sequence multiple human genomes in less than a week.

However, substantially longer time periods and heightened bioinformatics skills are required to analyse, understand and generate meaningful results from the enormous data sets generated by genomes, transcriptomes and epigenomes. The initial bottleneck is the data processing, analysis and integration of HTS data generated from different applications. Translating

these findings into clinical applications presents even more challenges.

This is due not only to the volume of the data being generated, but also the complexity of it. With high throughput sequencing, the DNA of an individual is sheared into many small fragments. All the fragments are then immobilised onto a solid support and ‘read’ simultaneously using fluorescently tagged nucleotides. Images are captured at every stage and the fluorescent signal converted into a DNA sequence. Each sequence is linked to its coordinates on the solid support, effectively giving independent sequence data for each fragment. All the data is then put



together again to build the entire sequence of the 3 billion nucleotides that make up the human genome.

Next, the data is compared to reference sequences so that variations that could be the cause of disease can be pulled out and analysed further. Bioinformatics techniques play an important role here since it is not possible to manually carry out the data capture, alignment and variant identification. Furthermore, computational algorithms and pipelines allow different scenarios to be designed and quickly executed to analyse the data under different models of inheritance.

Therefore, life scientists, who are generating the data, are facing difficulties in the downstream handling of the data due to the lack of basic computational and statistical knowledge, becoming dependent on the support of bioinformaticians or statisticians. Not an easy task due to the scarcity of bioinformaticians and statisticians with the biological background required to be able to analyse and evaluate these large data sets with a profound biological insight.

The TrainMALTA project, funded through a H2020 Twinning grant under agreement number 692014, aims to tackle these limitations by providing diverse forms of training in bioinfor-

matic analysis, enabling researchers at the University of Malta to gain new insights into the genetic causes of disease. This support and coordination action aims to achieve this through providing researchers with a solid understanding of the basis of data analysis, enabling life scientists to analyse and interpret HTS data within a biological and clinical context. This is best achieved through collaborations between life scientists, bioinformaticians and statisticians.

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**“HTS has changed the way genetics and molecular biology research is carried out. In the very near future, HTS will also find widespread application in the clinical diagnostics of Mendelian disorders, greatly improving on the 20% diagnostic sensitivity of the current Sanger candidate gene approach.”**

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A wide range of bioinformatics techniques and software tools are available today, enabling researchers to draw new insights from biological datasets. The volume of data being generated and the rapid development of bioinformatics techniques means there is an ongoing need to provide high-quality training, an issue which lies at the core of the TrainMALTA project. It is also crucial to integrate this training with ongoing local research into the background of disease.

Thus, the priority of the TrainMALTA project is to equip researchers with the inter-disciplinary skill sets that they need to analyse HTS data using informatics, command line open-source tools and high-throughput analysis pipelines and a solid appreciation of the limitations of each technique and analysis pipeline being used. Analysis of these data-sets could help researchers learn more about the underlying causes of disease, marking another step towards the wider goal of personalised medicine.



**Rosienne Farrugia**  
Department of Applied Biomedical Science  
Faculty of Health Sciences  
University of Malta  
Tel: +356 2340 1107/3281  
[www.um.edu.mt/project/trainmalta](http://www.um.edu.mt/project/trainmalta)  
[www.twitter.com/uniofmalta](https://twitter.com/uniofmalta)



# Natural colours from cellulose

Silvia Vignolini, Reader in Chemistry and Biomaterials at University of Cambridge explores the wonderful world of colour and how it affects our perception and mood

Colour is a powerful communication tool, it deeply affects our perception of the world, stimulating our senses. It is not by chance that since the beginning of our society colouration is used as a visual marker for concepts such as quality and desirability. Industry today employs synthetic pigments to colour the objects around us, however there is a growing demand for natural methods of producing colorants for many applications. This challenge has inspired a new project headed by Dr Silvia Vignolini to develop a sustainable and scalable pathway to innovative natural pigments.

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**“Cellulose is the most abundant biopolymer on the planet and therefore is a truly renewable and sustainable resource. Its natural degradation pathway avoids concerns over bio-accumulation, an area of intense scrutiny as the environmental implications of synthetic micro-plastics becomes more apparent.”**

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## Colourants in industry

Colourants are used universally in industry, from paints and cosmetics to food and textiles, where they play a central role in visually upgrading a product by acting as a gauge for quality, attractiveness, freshness or taste. The pigment industry has long relied on the use of complex synthetic dyes or inorganic particles to produce colours and visual effects (e.g. hues, brightness, shine).

However, there is a growing demand for more natural or environmentally-friendly ways to add colour – especially in food and cosmetic products. Dyes are commonly used to enhance the look of food and food packaging but have long been tainted with controversy, with concerns over toxins and health impacts – to a point where consumers are increasingly scrutinising ingredients for anything that looks unnatural and potentially harmful.

The bio-inspired photonics group, led by Dr Silvia Vignolini, is taking a different direction. By drawing inspiration from nature and exploiting sustainable biomaterials, such as cellulose or chitin, her group focuses on manufacturing colours by carefully controlling the assembly of matter on the nanoscale rather than chemical composition. Such non-fading “structural colouration”, is responsible for many of the most vibrant colours in nature, as found in the wings of butterflies, the feathers of birds and in the epidermis of plants.

## Cellulose-based pigments

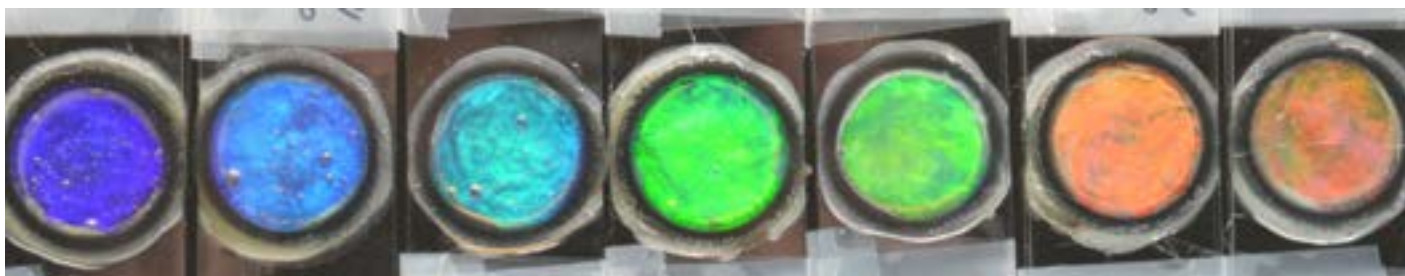
The strategies that have been developed in nature to create colour are incredibly optimised. By directing the assembly of discrete biological building blocks, typically biopolymers (e.g. proteins and polysaccharides) or nanoscale mineral deposits, natural architectures produce not only intense coloration but also often display intriguing visual effects, such as iridescence.

Cellulose, for example, is ubiquitous in the cell wall of plants and is responsible for the high rigidity in wood. However, in certain fruits and leaves, the cellulose fibres are assembled at the nano-scale into a helicoidal structure, such that it intensely reflects blue light. By replicating the natural assembly process within the plant cell and embedding it into materials, the researchers are developing a range of cellulose-based “photonic” pigments.

Cellulose nanocrystals, extracted from naturally-abundant cellulose fibres, are a highly promising material due to their inherent biocompatibility, biodegradability and scalable production. When dispersed into water, cellulose nanocrystals have been shown to spontaneously assemble on the nanoscale to mimic the natural helicoidal architecture. Upon drying, this structure is retained, enabling the reflection of visible light. Using this approach, the researchers can produce colours from across the entire spectrum, from ultraviolet to infrared, with an optical appearance tailored from matte to glossy or metallic. The key challenge now is how to develop large-scale fabrication of cellulose-based photonic pigments.

## Scalable manufacturing

Cellulose nanocrystals are an industrial reality, with the number of patents increased exponentially over the last decade. The development of cellulose-based photonic pigments is



*Cellulose colours. In contrast to colouration obtained by pigmentation, structural colouration can obtain every colour of the rainbow using only one material: cellulose*

therefore extremely timely, with growing industrial interest both from the manufacturers, who are eager to push cellulose in novel application directions and from end-users in seek of natural and sustainable alternatives to conventional pigments.

Cellulose-based pigments are suitable for use in printing ink (\$20.4 billion by 2022), colouration of food (\$ 3.75 billion by 2022), cosmetics (\$429.8 billion in 2022) and sun-creams (\$11.1 billion in 2020). The successful scale-up of the fabrication of cellulose-based photonic pigments will allow for the manufacture of a truly sustainable, biocompatible and potentially edible alternative to conventional synthetic dyes for mass-market applications.

The Vignolini group has recently developed a disruptive methodology to control the assembly of cellulose nanocrystals in the confined geometry of a micron-sized water droplet. Upon drying, each droplet produces a single coloured cellulose nanoparticle that can be used as a photonic pigment. The advantage of their patented approach is that it can readily build upon existing industrial emulsion technologies to produce a dry powder that can be directly incorporated into existing formulations, eliminating the need for synthetic dyes.

The researchers are now exploring the scalability of this methodology and how it can be translated out of

the laboratory to an industrial-scale process capable of meeting the demands of the pigment industry. To this end, Silvia Vignolini has established close collaborations with leading pigment companies and end-users that will ensure the best chance of exploiting the new and exciting opportunities born from the project's research.

By understanding the fundamental science behind the assembly of cellulose nanocrystal droplets many new technological possibilities will be opened, which is why the researchers are also actively exploring how cellulose-based pigments can be coated directly onto a surface for use in security printing or as smart/responsive packaging.

### **A truly renewable and sustainable resource**

Cellulose is the most abundant biopolymer on the planet and therefore is a truly renewable and sustainable resource. Its natural degradation pathway avoids concerns over bio-accumulation, an area of intense scrutiny as the environmental implications of synthetic micro-plastics becomes more apparent.

Additionally, by removing the dependence on mica, a glittery mineral used in car paint and makeup and whose extraction raises ethical concerns over child labour in illegal mines, cellulose-based photonics has the potential to

have significant societal as well as environmental impact. Therefore, the pioneering science undertaken by the bio-inspired photonics group could have far-reaching appeal as they examine new ways to mimic nature's methods of producing colour.

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**“Colourants are used universally in industry, from paints and cosmetics to food and textiles, where they play a central role in visually upgrading a product...”**

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**UNIVERSITY OF  
CAMBRIDGE**

**Dr. Silvia Vignolini**  
**Reader in Chemistry and Biomaterials**  
 University of Cambridge  
[sv319@cam.ac.uk](mailto:sv319@cam.ac.uk)  
[www.ch.cam.ac.uk/group/vignolini](http://www.ch.cam.ac.uk/group/vignolini)  
[www.twitter.com/VignoliniLab](https://twitter.com/VignoliniLab)

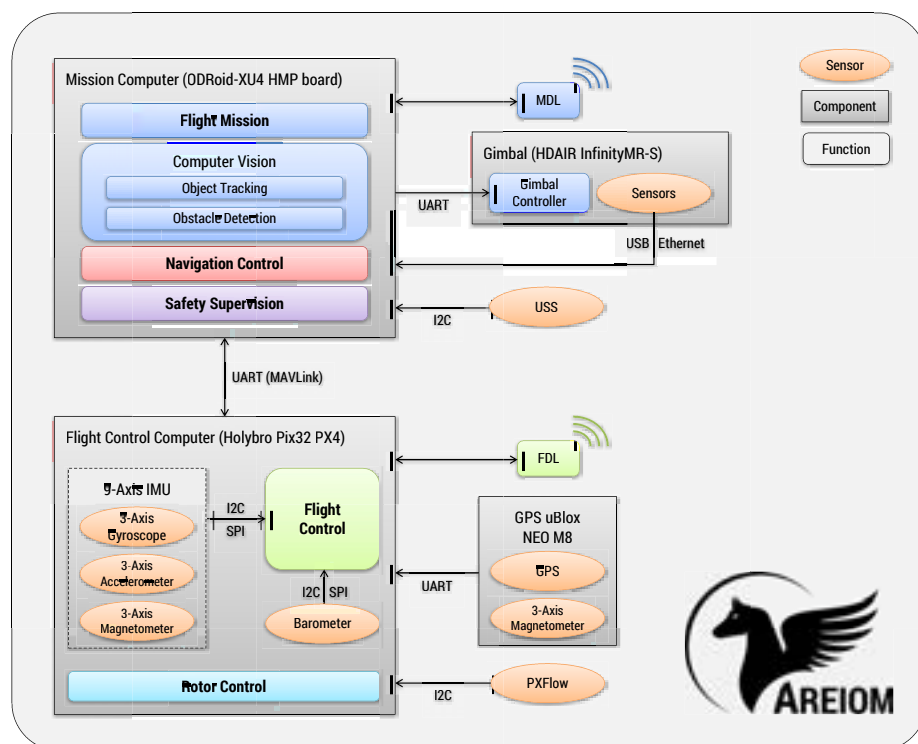
# Adaptivity boosts unmanned micro air vehicles (MAV) in urban environments

Wolfram Hardt, Professor at Chemnitz University of Technology gives insight into their ongoing adaptive mission research for unmanned micro air vehicles (MAV)

Unmanned micro air vehicles (MAV) have spread widely in use during the last few years. Pilots control their MAV by remote control and video streams. The market for technical entertainment offers various MAV platforms equipped with sensors and cameras. For the main part, but the total weight of 2.5kg is not reached due to both handling and licensing reasons.

However, the tremendous number of applications, as well as the fascination of both pilots and users indicate a new upcoming field for professional applications for unmanned micro air vehicles (MAV). In our view, professional MAV technology offers additional resources in terms of energy capacity, standard sensors, as well as special sensors, multi-cameras and computation capacity. This increases the total weight up to 20 kg. High sophisticated flight control algorithms ensure comfortable flight characteristics and additional controllers stabilise both the central gimbal carrying cameras and special sensors.

Recent developments focus on all technical aspects and flight support functions. So, piloting becomes easy. The market for technical entertainment also offers the first autonomous MAV functions. Simple algorithms implement autonomous functions, e.g. return-to-home, follow-me as well as height limits, distance limits and recognition of NoFlyZones. Ideas for complex autonomous missions such



as package-delivery in urban environments are still the subject of research and first prototypes for such evaluations are coming up.

The computer engineering group at Chemnitz University of Technology has been doing research on efficient hardware/software control applications since 2003. Results point out that the design of efficient systems optimises the computing architecture, with respect to the application. This is especially true for high-performance applications such as autonomous MAV missions, whereby the computing architecture must be composed with respect to this kind of application.

The challenge is, to design a computation platform that provides sufficient computation power, e.g. for real-time online image processing within the tight restrictions of both power consumption and total weight. For this reason, we developed the adaptive research platform AREIOM. The AREIOM platform defines five separate architecture levels for specific MAV tasks, especially three control levels for handling the rotors, the flight parameters and the navigation functions are distinguished. Additional architecture levels are introduced for safety supervision and the flight mission. Sensors and gimbal can be connected by standard interfaces.

In addition, previously discussed standard functions are implemented on the named control layers. The newly introduced flight mission layer offers computation resources for adaptable flight missions. Based on adaptability, autonomous missions for applications of limited complexity are implemented successfully. In this respect, applications in view are object inspections with optical and thermal cameras, industrial inspections, such as power lines and high voltage isolators.

Also, railway inspections, control of huge aeries such as marshalling yards and private house security tasks can be implemented with adaptive MAV technology. Such applications find an exponentially growing market in urban regions, if autonomous mission execution can be provided.

Based on our AREIOM platform, the concept of adaptive MAV mission has been developed and provides:

## • Flexibility:

Adaptive MAV are not bound in their movements to a predefined infrastructure, such as streets or railways. Thus, MAV can be utilised independently of the costly infrastructure of urban environments. This reduces mission costs enormously.

## • Agility:

MAV are highly agile vehicles with the ability to operate within a small area. MAV flight control and navigation control ensure agility, within an accuracy of just a few centimetres. Vertical take-off and land, turn-on-the-spot, fly-over and fly-under hindrances are examples of the agile abilities of MAVs. In urban environments, small area scenarios are typical and with adaptive MAVs and such locations can be both accessed and inspected.



Prof. Dr. Wolfram Hardt

## • Adaptivity:

The ability to operate within a small area is imperative for professional MAV applications in urban environments today. Adaptive methods offer the necessary functions. In our research, we develop such adaptive methods, working in two phases.

In phase one, complex sensing is done to capture all information about the surrounding areas that the MAV is operating in. This includes hindrances, determination of inspection objects as well as detection of moving elements, e.g. vehicles, persons and animals. In this phase, we apply high-performance image processing. Image data is taken from a separate camera. Image processing includes pre-processing, object detection and objects recognition. This image processing phase can be accelerated by usage of FPGA technology for analysis of up to 700 fps. Image processing results in the determination of the so-called facts. For example, "inspection object found" can be such a fact. All facts are defined with respect to the application in view, so by this we describe the changes in the actual scenario.

In phase two, we calculate the facts of

the next flight and navigation command of the mission. This calculation is also of a high complexity and must be executed in real-time. Different algorithms can be chosen. Artificial intelligence methods are well suited for this problem. Machine learning approaches require knowledge from characteristic examples to learn from. Such data can be collected by manual test missions if the mission application is predefined. Other approaches are expert system based. In this case, all possible decisions are summarised in decision graphs which can be traversed. Different techniques for acceleration can be applied to meet the real-time requirements. We evaluated the well-known RETE-algorithm and introduced some optimisations. This leads to real-time responsiveness and reliable adaptive flight missions.

The AREIOM-Two-Phase calculation of adaptable missions could be implemented successfully on the AREIOM-platform. This new approach of adaptable MAV boosts the application of this technology in urban environments and opens new markets rapidly growing.



TECHNISCHE UNIVERSITÄT  
CHEMNITZ

Prof. Dr. Wolfram Hardt

Stephan Blockzyl, Dipl. Inf.

Chemnitz University of Technology

Tel: +49 371 531 25550

hardt@cs.tu-chemnitz.de

www.tu-chemnitz.de/cs/ce

www.twitter.com/WolframHardt



# Phosphorus geomicrobiological research – biology, chemistry, and agriculture

Diliana D. Simeonova of the Bulgarian Academy of Sciences imparts her seasoned expertise on phosphorus geomicrobiological research

Phosphorus is one of the five vital elements, together with carbon, nitrogen, oxygen and hydrogen, plays a crucial role in the life on our planet. It is a structural and functional component in all organisms and is found in vital cell constituents as nucleic acids, nucleotides, phosphoproteins, phospholipids and others. In all these components, however, Phosphorus is present in its higher oxidation state [P, +V] as phosphate. Its abundance at the surface of the Earth has been estimated to be 0.10–0.12% (w/w).

The world's mineral phosphate resources are finite; therefore, there is a need of efficient phosphorus processing by developing strategies for its reuse, recovery and recycling.

The inorganic P exist in five different oxidation states [-III, 0, +I, +III, +V], where phosphate [P, +V] is the growth-limiting nutrient predominantly in water environments. Thus, organisms able to utilize alternative P –sources (reduced P forms) have an ecological advantage and importance under P-limiting conditions. Phosphite [P, +III] is used in different formulations as a fungicide, fertiliser (it is assumed that soil bacteria oxidize phosphite to phosphate is an indirect P source for higher plants) and fumigant (high toxicity for insects).

The organophosphonates are organic compounds having P in [+III] oxidation

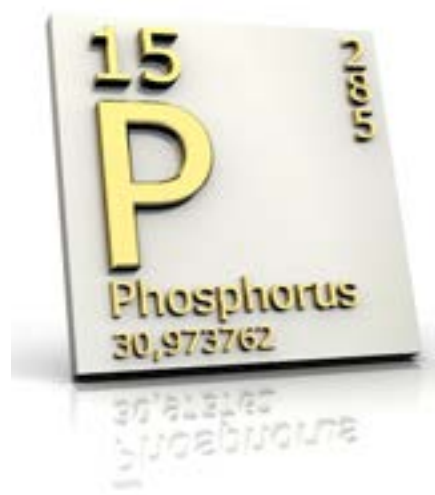
state and are characterised by a stable covalent carbon-phosphorus (C-P) bound. Phosphonates have many industrial applications such as herbicides, detergent additives, medical applications (antibiotics) and others. Organophosphonates as reduced inorganic P species has been demonstrated to serve as alternative P sources to some microorganisms. Nonetheless, most of the anthropogenic polyphosphonates are assumed as resistant to bacterial degradation.

**“The world's mineral phosphate resources are finite; therefore, there is a need of efficient phosphorus processing by developing strategies for its reuse, recovery and recycling.”**

## Phosphorus geomicrobiological research platforms

Due to the importance of phosphorus being a non-renewable and non-substitutable resource for food production, essential for agriculture and food security and providing the ongoing international pressure on raw materials and food production, the need of phosphorus management will remain.

In March 2013 was created the European Sustainable Phosphorus Platform after the first European Sustainable Phosphorus Conference aiming at the improvement and enlargement of the knowledge over phosphorus cycling, losses and the efficiency of its processing in different environments (natural and manmade). This platform strength-



ens and creates new links, facilitates discussion between the market, stakeholders and regulators. It ensures knowledge and experience sharing, creates networks on phosphorus management and contributes to define a long-term vision for phosphorus sustainability in Europe.



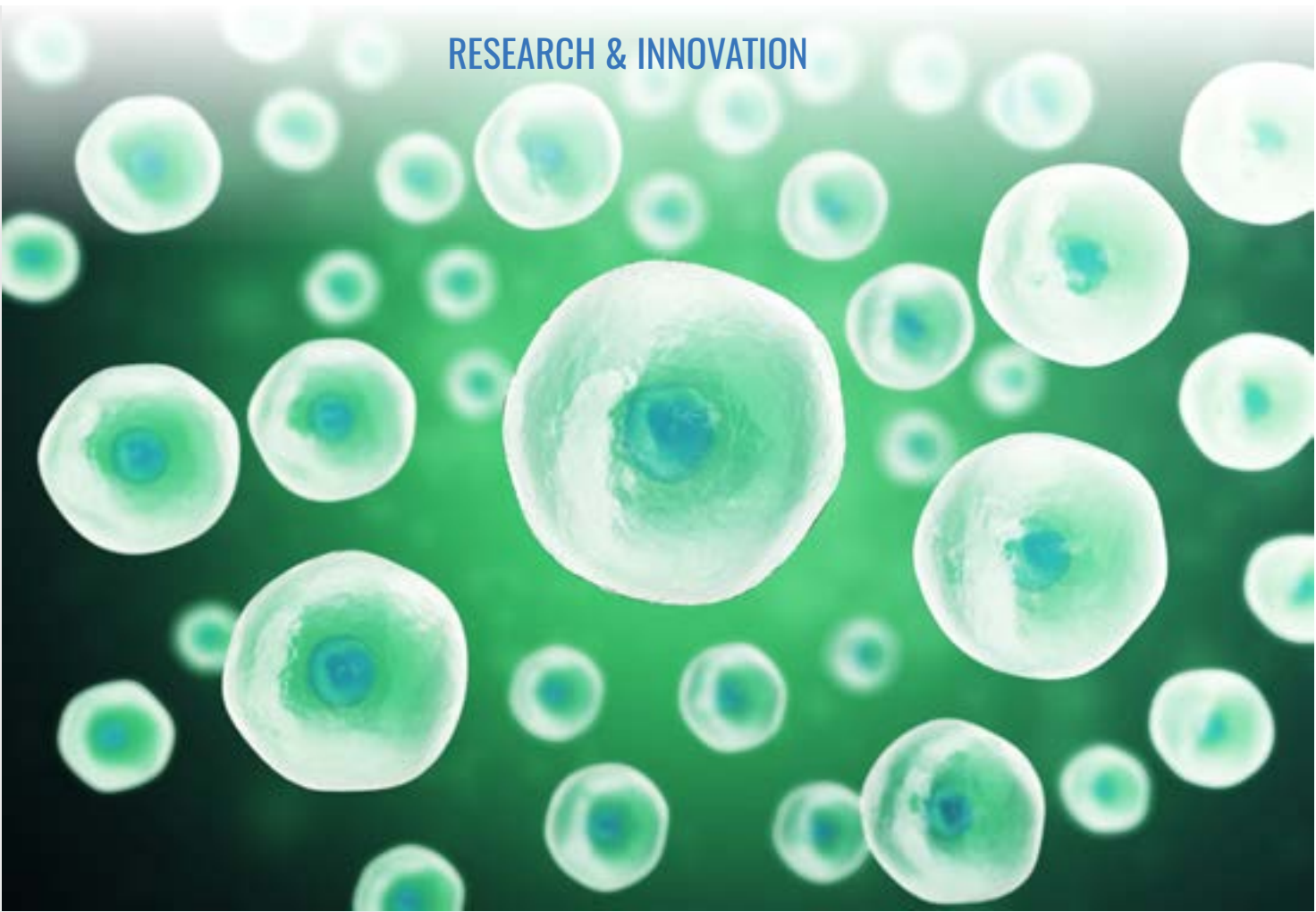
**Diliana D. Simeonova**  
**Assistant Professor**

The Stephan Angeloff Institute of Microbiology, Bulgarian Academy of Sciences, Bulgaria

Tel: +359 2 979 3115

dsimeonova@microbio.bas.bg

<http://microbio.bas.bg/>



# What is developmental biology and why is it important?

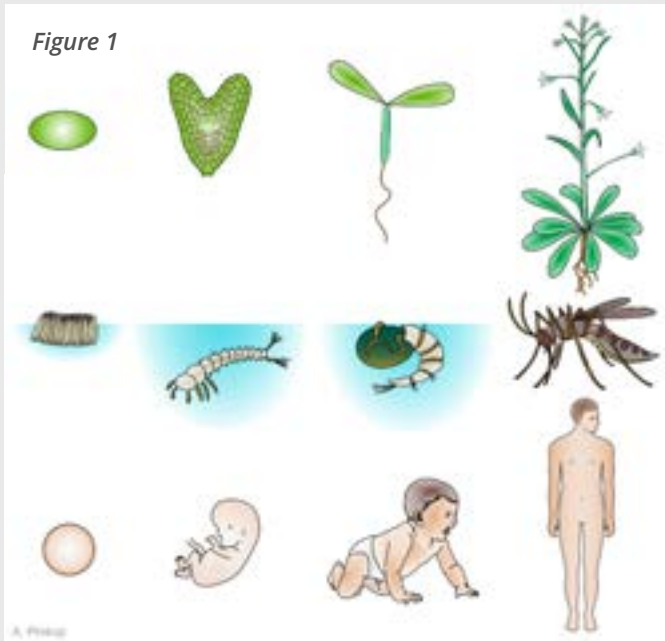
Andreas Prokop from the British Society for Developmental Biology explores how developmental biology (DB) addresses questions of societal importance

**T**he life science discipline Developmental Biology (DB) aims to understand the processes that lead from the fertilisation of an egg cell (or equivalent) to the formation of a well-structured and functional multicellular organism (Fig.1). At first sight, this may appear a mere curiosity-driven academic goal, not necessarily worth taxpayers' money. Here I argue that the opposite is true: DB is a key discipline in the life sciences, a motor for research into human disease and fertility, food sustainability and biological responses to environmental pollution and global warming.

According to the US' National Research Council, over half of initial pregnancies are affected by developmental defects, ~3% of live births suffer from major devel-

opmental aberrations, ~70% of neonatal deaths and 22% of infant deaths have developmental causes and ~30% of admissions to paediatric hospitals are due to developmental defects. The causes can be random errors, inherited or acquired gene mutations or toxins – as illustrated by severe limb malformations of thousands of new-borns during the thalidomide/Contergan drug scandal in the 1950s, or the stark increase in birth defects after the Bhopal gas catastrophe in 1984.

These numbers and examples clearly cry out for scientific investigations into the developmental processes affected – not only to understand or even treat human disorders but also to deliver profound arguments that convince policy makers, for example, to reduce toxic



wastes, fumes and plastics which pose threats to our healthy genes and development. DB is a scientific discipline at the centre of such investigations and it has two important strategic strengths, as will be explained in the following article.

## DB asks profound questions at the level of whole organisms or organs

DB investigates questions such as “how does the kidney or brain develop?”, or “how do limbs or leaves achieve their characteristic shapes and positions?” To address such questions, a typical DB research strategy may start by identifying the genes or gene networks regulating the respective developmental processes in a chosen animal or plant. These genes can then be functionally manipulated or eliminated to study the resulting developmental aberrations. The findings often allow deductions about how the involved genes and processes function in health; they may also reveal parallels to clinical cases of human developmental disorders, thus directing further biomedical research into such conditions.

To investigate processes from the genetic level all the way up to the organism/organ level, DB must be highly inclusive and interdisciplinary, making active use not only of genetics but also biophysics, biochemistry, cell biology, physiology and anatomy. In this way, it drives discoveries at the various levels of complexity, acts as an umbrella discipline that can provide a common focus towards essential biological questions and builds

bridges to clinicians or plant/animal breeders who tend to think at the organism/organ level.

## DB makes strategic uses of model organisms

Most DB research does not use human embryos but covers the breadth of the animal and plant kingdoms. This ambition might seem to bear the risk of overstretching our research capacities, but it is, in fact, a great strength of DB and gold mine for discovery. It turned out that many genes and functional gene networks that steer fundamental biological processes have ancient evolutionary origins and are still being used by very different species for similar purposes (Fig. 2); ~75% of human disease genes have a counterpart in fruit flies and ~50% of yeast genes can be functionally replaced with human genes.

Capitalising on this principle of ‘deep homology’, highly efficient and cost-effective, hence economically responsible research can be done in smaller organisms, such as worms, flies or even yeast. The genes and concepts learned can then be tested in mammals (most frequently mice) and eventually used for clinical trials. This discovery pipeline has led to significant understanding of human biology and disease, as evidenced by an impressive number of Nobel Prizes in Physiology and Medicine awarded to scientists working with these “model systems”.

## What DB has done for us (so far)

DB research starts with the fertilisation of egg cells; studying the underlying processes has provided the foundations for much of what fertility clinics can do these days. DB investigates how fertilised egg cells divide in regulated manners to grow into full-size bodies, how the cells formed in this process communicate in meaningful ways to become different from each other, migrate, change shape and attach to each other, thus assembling into tissues and complex organs. Many of these processes are needed again during wound repair and DB research helps to speed up wound healing, prevent scars and overcome chronic wounds.

Also ‘tissue engineering’, which aims to grow replacement tissues in a plastic dish, is essentially guided by DB research. In cancer, cells lose their identity, divide excessively, detach from their local environments and migrate to form metastases. Much of this understand-



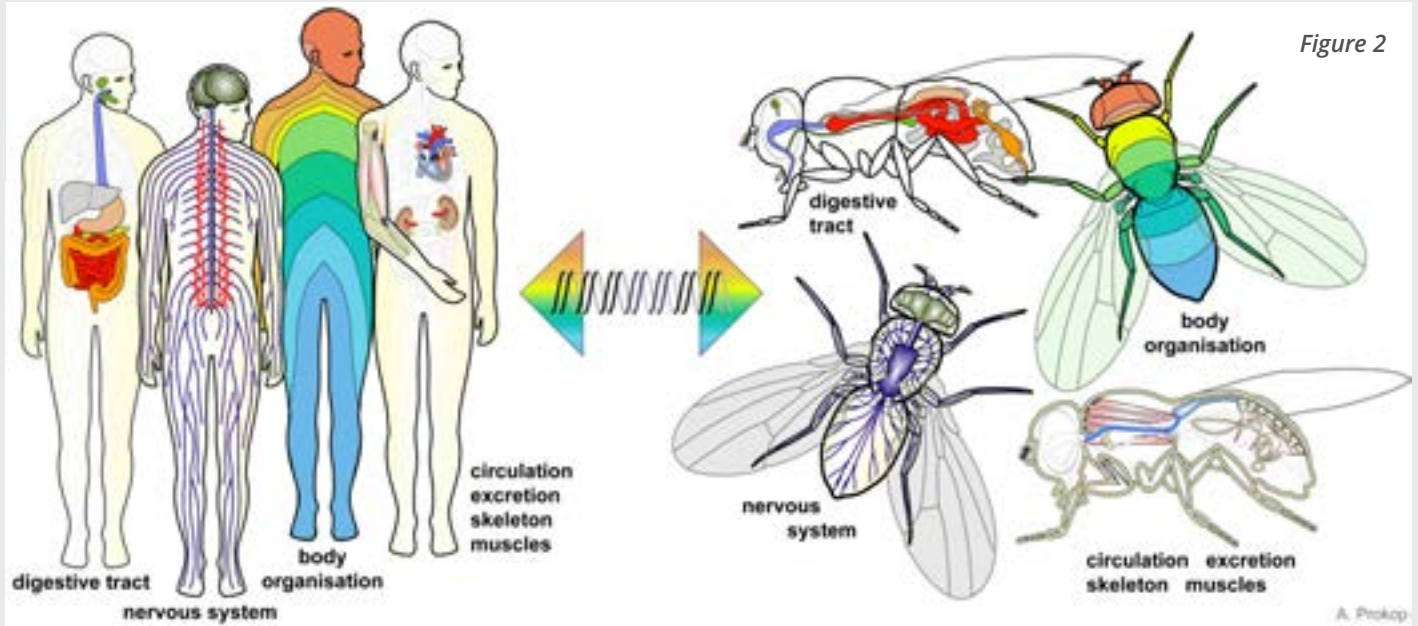


Figure 2

ing that can instruct cures to contain these aberrant cells, comes from DB research. Tissues keep so-called stem cells which can be re-activated in orderly manners to divide and grow replacement tissues. There are high hopes from stem cell research, for example, to replace cartilage in arthritis or damaged discs, or brain cells in dementia, much of which is guided by the vast knowledge gained through DB.

**“Most DB research does not use human embryos, but covers the breadth of the animal and plant kingdoms. This ambition might seem to bear the risk of over-stretching our research capacities, but it is, in fact, a great strength of DB and gold mine for discovery.”**

The applications of DB go far beyond biomedical research. For example, understanding plant development provides a means to speed up breeding processes, such as optimising root systems, plant size or flowering time, thus contributing to the efforts of achieving sustainable food security in times of over-population. Furthermore, understanding environmental influences on development, such as temperature-dependent sex determination in turtles, has enormous importance for conservation biology, especially in times of increasing pollution and global warming.

In conclusion, DB may appear as a mere academic discipline, but its value for society is enormous. This should make us think about a carefully balanced system of science funding. Current trends seem to

favour clinical or industrial research performed to translate biological knowledge into an economic or societal benefit. But we must not overlook that fundamental research, such as in the field of DB, lays the long-term foundations for such developments. ■

The author would like to thank Ottoline Leyser and Aidan Maartens for helpful comments on this manuscript. Andreas Prokop is Professor of Cellular and Developmental Neurobiology at the Faculty of Biology, Medicine & Health (The University of Manchester) and communication officer of the British Society for Developmental Biology.

**Andreas Prokop**  
**Professor of Cellular & Developmental Neurobiology**  
 BSDB – British Society for Developmental Biology  
 Tel: +44 (0)161 275 1556  
 Andreas.Prokop@manchester.ac.uk  
<http://bsdb.org/>  
[www.twitter.com/Poppi62/status/932523941033316352](https://twitter.com/Poppi62/status/932523941033316352)



# Extreme muscle plasticity or novel myogenic precursors in skeletal muscle

Graciela A. Unguez, Professor of Biology at New Mexico State University sheds light on skeletal muscle in vertebrate animals

Skeletal muscle is one of the most abundant tissues in vertebrate animals. Skeletal muscle is also very diverse, as it is comprised of muscle cell types that differ in their biochemical, morphological and functional properties. Skeletal muscle heterogeneity is further emphasised by the variable sensitivity of distinct muscle cell phenotypes to exercise, nerve-dependent electrical activation patterns, denervation, regenerative capacity following injury or disease and aging.

In the last four decades, studies have also elucidated that muscle heterogeneity is manifested during embryonic development when distinct classes of myogenic stem cells, or satellite cells, associated with different muscle groups are involved in muscular patterning, growth and regeneration. Moreover, postnatal muscle cells demonstrate a great ability to respond to changes in environmental signals, by altering their gene expression and adapt to new physiological demands. Here, the robust heterogeneity of vertebrate skeletal muscle cells and their plasticity is examined from the perspective of some teleost species that possess highly specialised non-contractile myogenic tissues.

## Intermittent muscle contractility exchanged for continuous electrogenesis

In electric fishes from South America (Gymnotiforms) and Africa (Mormyrids),

some skeletal muscle fibers exhibit an extreme phenotypic plasticity by losing their contractility during normal development to give rise to electrocytes, the specialised cells that generate electricity and make up the electric organ (EO) (Bennett, 1971). The cells that make the EOs are not only novel in their morphology, gene expression, and functional specialisation but also unique in that they retain some phenotypic properties of their mature muscle precursors.

Currently, it is thought that one key event in evolution of electric fish was the origin of the EO from the complete transformation of striated muscle during development wherein partly or fully differentiated muscle fibers disassemble their contractile apparatus, undergo striking changes in shape and size, and become innervated by a separate population of spinal motoneurons known as electromotoneurons (Bennett, 1971).

Whether electrocytes arise from a population of embryonic cells separate from that of muscle is not known. Histological data from an ontogenetic study by Kirschbaum and Schwassman (2008) suggested the presence of a germinative zone located below the hypaxial muscle region that contains electrogenic precursor for electrocytes. These electrogenic precursors appeared to differentiate without going through a true muscle fiber stage. The authors interpreted these

findings to support the existence of unique electrocyte precursors, they referred to as “electroblasts”.

A presumed electroblast-dependent origin of electrocytes during early postnatal development is not fully recapitulated during regeneration in adult *Sternopygus. macrurus* (Weber et al., 2013). Specifically, following tail amputation, Pax-7 positive satellite cells associated with both intact electrocytes and muscle fibers proximal to the cut site begin to replicate and contribute to the formation of fully striated muscle fibers.

The muscle fibers located most centrally and expressing fast myosin heavy chain (MHC) differentiate into myotubes, that contain fully mature sarcomeres, fuse and then proceed to disassemble the striated complexes while also downregulating many of the sarcomeric genes to give rise to the non-contractile electrocytes (Unguez and Zakon, 1998a).

Hence, the cellular processes of electrocyte regeneration in the adult cannot be fully compared with those observed during postnatal development. Firstly, although distinct populations of Pax-7 positive cells are associated with mature muscle fibers and electrocytes in adult tails (Weber et al., 2013), Pax-7 immunolabeling was not carried out in the postnatal developmental study. Future studies should determine whether “electrob-

lasts" in early postnatal electric fish express Pax-7, fuse to generate the multinucleated electrocytes (Unguez and Zakon, 1998a; Weber et al., 2013), and transiently express fast-MHC. These data would be first in demonstrating the existence of Pax-7 positive stem cells that contribute to the development and regeneration of a highly specialised non-contractile myogenic cell type in vertebrates.

Although much about the origin of the electric organ from muscle remains unknown, such understanding is a reachable goal in the near future. Recognising and elucidating the cellular and molecular programs that give rise to the non-contractile current-producing cells of the electric organ will not only expand the breadth of the known heterogeneity and plasticity of striated muscle, but will be key to unravelling the evolution of myogenic electric organs.

### Intermittent muscle contractility exchanged for thermogenesis

Additional cases of fish skeletal muscles being modified for non-muscular functions also include those in some groups of oceanic fish, commonly known as billfish. In billfish, extraocular muscles (EOMs) transform into a heat-generating organ located beneath the brain and close to the eyes (Block, 1986). This thermogenic organ is composed of modified EOM cells (heater cells) that are structurally distinct from all other types of skeletal muscle.

In the superior rectus muscle of billfish, myofibrils and contractile filaments are virtually absent, multiple nuclei are centrally located, and the cell is packed with mitochondria and smooth membranes (Block, 1986). That thermogenic cells derive from

striated muscle precursors is evident by the presence of isolated patches of disarrayed myofilaments. Heater cells of the adult organs also express contractile proteins associated with fast-twitch fibers (Block, 1986; Tullis and Block, 1997).

For example, two key SR proteins associated with calcium transport, the SR Ca<sup>2+</sup> – ATPase and the SR Ca<sup>2+</sup> release channel link heater cells to fast-twitch muscle fibers (Block et al., 1994; Tullis and Block, 1991). The high degree of similarity between heater cells and fast-twitch muscle fibers would favour development from myoblasts that give rise to fast-twitch fibers. Together, data from characterisation of electrocytes in *S. macrurus* and heater cells from billfish demonstrate that muscle tissue has a high degree of functional plasticity. Interestingly, the incidence of a higher degree of plasticity among fast muscle fibers phenotypes may be an inherent characteristic maintained across species.

It is not known how or when the heater phenotype develops in the extraocular muscles. Heater cells could develop directly from myoblasts without first passing through a contractile stage. Alternatively, mature contractile muscle fibers could be directly transformed into heater cells. Unfortunately, for both electric fish and billfish, breeding in captivity is extremely challenging, and it is difficult to obtain larval and juvenile animals, which precludes direct examination of the developmental trajectory of muscle fibers into electric organ and heater cells.

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**Graciela A. Unguez, PhD**  
**Professor of Biology**  
 New Mexico State University  
 Tel: (575) 646 7963  
 gunguez@nmsu.edu

# Astronomy and the universe of discovery

Richard F. Green, Director, Division of Astronomical Sciences, U.S. National Science Foundation (NSF) explores the wonders of astronomy and the universe of discovery

**I**n October 2017, telescopes across the globe observed a kilonova radiating from a galaxy 130-million-light-years from Earth. Thousands of scientists saw the event unfold, the explosive aftermath of paired neutron stars colliding. Selected by [\*Science Magazine\*](#) as its [\*Breakthrough of the Year\*](#), it was the first time in history that the world's telescopes were guided to a new discovery by gravitational wave detectors and it ushered in a new era for astronomy.

The merger's initial detection by NSF's Laser Interferometer Gravitational Wave Observatory (LIGO) and Europe's Virgo facility was exciting, but the [\*historic breakthrough\*](#) was the rapid deployment of other observatories to identify and then image, the radiating

emissions. Six research teams independently made the initial optical identification; four were based in the United States and NSF Astronomy supported all four. NSF continues to highlight this multi-messenger revolution as one of its major cross-cutting themes: Windows on the Universe.

The NSF Division of Astronomical Sciences has a mission to promote such excellence in U.S. ground-based astronomy. Toward that goal, the Division invests in three approaches: support the programmes of individual investigators, provide access to world-class research facilities and datasets; and enable the development of new instrumentation and next-generation facilities – all through competitive merit review.



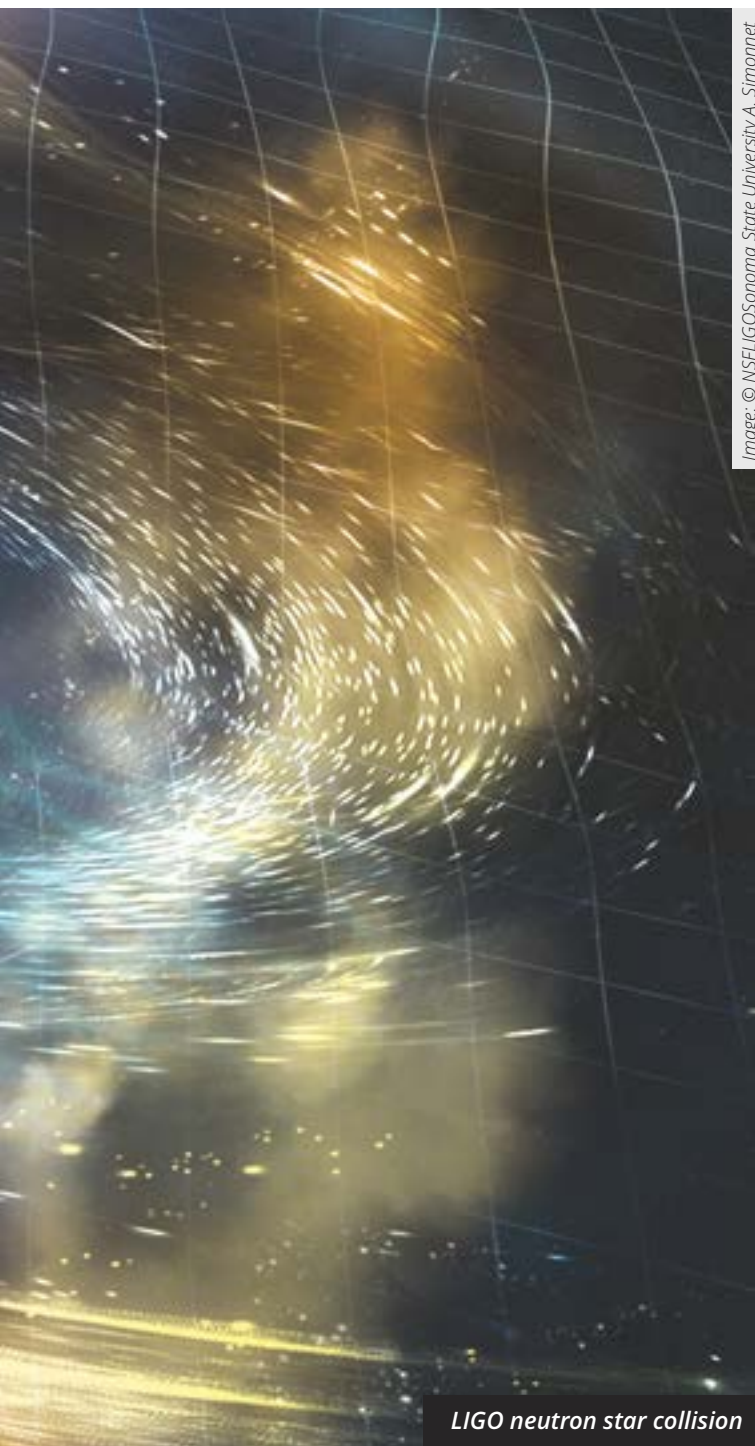


Image: © NSF/LIGO/Sonoma State University A. Simonnet

LIGO neutron star collision

Also last year, the Atacama Large Millimeter Array (ALMA) captured the telltale signature of the cold gas and dust energised by newly formed stars. While such a signature is not uncommon, this discovery also raised interesting questions: the newly formed stars are in the immediate vicinity of the four-million-solar-mass black hole in the centre of our Milky Way Galaxy. Conventional wisdom suggests the powerful radiation and particle jets from that black hole disrupt the cold condensation of gas that leads to new stars, so the discovery is a surprise and a puzzle.

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**“The NSF Division of Astronomical Sciences has a mission to promote such excellence in U.S. ground-based astronomy. Toward that goal, the Division invests in three approaches: support the programmes of individual investigators, provide access to world-class research facilities and datasets; and enable the development of new instrumentation and next-generation facilities – all through competitive merit review.”**

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And perhaps most widely reported and tied to the nation’s most popular astronomical event in some time, NSF’s National Solar Observatory (NSO) recruited citizen scientists to track the U.S. solar eclipse in August 2017 for the entire duration of its transit. The resulting video captured the public’s imagination and raised NSO’s profile and provides the longest data set of its kind.

This year, NSO also drew attention for its recent development of state-of-the-art techniques for sharpening real-time images of the sun to correct for the blur of the Earth’s turbulent atmosphere. The resulting images reach a resolution of 40 km over an extent of 25,000 km on the sun’s surface. This same technology applied at the nearly completed Daniel K. Inouye Solar Telescope (DKIST) will achieve 2.5 times sharper imaging, enabling scientists to understand in detail the bubbling of gas that transports heat to the sun’s surface along with the magnetic fields that create space weather.

The current flagship facilities in ground-based astronomy are truly multi-national in nature. For example, the three executives of ALMA are NSF, the European

### The result? Breakthrough science

For example, on December 6th, 2017, Nature published online the discovery of the most distant quasar yet detected, a massive radiator of energy powered by an 800-million-solar-mass black hole. The research team, supported by our division, selected quasar candidates with distinct colour patterns using data from the NSF-supported Dark Energy Camera Legacy Survey on the NSF Blanco 4-metre telescope. The discovery was important not only for what it revealed, but also for the questions it raises. The black hole is from a time when the universe was only 5% of its current age – much less time than current models predict for a small black hole to grow to that size by accreting that much mass.





*Aerial of CTIO in Chile*

Southern Observatory and the National Astronomical Observatory of Japan, with Chile, Canada and Taiwan as collaborators. ALMA consists of 66 radio dishes located at an elevation of 5 km above sea level in the Atacama Desert of northern Chile.

The Gemini twin, 8-metre, optical-infrared telescopes are a fusion of national and international efforts. One of the telescopes is located on Cerro Pachón in northern Chile, while its twin is located on Mauna Kea in Hawai'i. The Gemini Observatory is operated as a partnership among the U.S. (represented by NSF), Canada, Chile, Brazil and Argentina, with South Korea as a limited-term collaborator.

Hawai'i is also the site of NSF's DKIST on the island of Maui, which is generating considerable excitement as it will be the world's largest solar telescope when completed in 2020. It will revolutionise our understanding of the sun's magnetic energy and its impact on space weather and the Earth. The UK and Germany are contributing to the first-light instrument complement.

Similar excitement is building for the Large Synoptic Survey Telescope (LSST), which will be a neighbour of Gemini South on Cerro Pachón in Chile. Its 8-metre primary mirror will focus on a 3-billion-pixel CCD camera, taking exposures every 20 seconds to produce a movie of the sky in multiple colours. It will ultimately measure the detailed properties of dark matter and dark energy,

while opening up the uncharted discovery space of the faint transient universe – the explosions and pulsations of distant stars and black holes and the motions of the myriad bodies in the inner and outer solar system.

LSST is supported by NSF, the Department of Energy and an international partnership including 23 countries through the LSST Corporation. Dealing with the flood of data from DKIST and LSST will require a new generation of techniques and data-handling interfaces, another major NSF initiative we call Harnessing the Data Revolution.

Recent advances in astronomy have been heavily driven by discovery from new data, new facilities and state-of-the-art instrumentation. The NSF Division of Astronomical Sciences supports the discoverers and their tools to drive those advances. ■

"The views expressed in this article do not necessarily represent the views of the National Science Foundation or the United States."

**Richard F. Green**  
**Director**

Division of Astronomical Sciences, U.S. National Science Foundation (NSF)  
Tel: +1 (703) 292 8820  
info@nsf.gov  
www.nsf.gov/div/index.jsp?div=AST

# Supercomputer simulations: Closing in on the story of our cosmic origins

Prof Romeel Davé, Chair of Physics at the University of Edinburgh explores how supercomputer simulations help to reveal how galaxies like our Milky Way arose from the Big Bang

**W**hy does the Universe look the way it does? This fundamental question has captivated humankind from the earliest days, spawning creation myths in every culture passed down through generations. Today, modern telescopes show us a fascinatingly complex Universe highlighted by billions of galaxies in a wide range of shapes, sizes and colours.

A modern creation story must account for this stunning diversity of galaxies and its emergence from the Big Bang. Galaxy formation simulators like myself use supercomputers to build an origins story based on the principles of physical laws rather than mythology. It is an epic challenge that will be a defining achievement for forthcoming generations.

Galaxy formation simulations aim to recreate the evolution of the Universe from the Big Bang until today using only the laws of physics and powerful supercomputers. Such simulations concurrently model the evolution of dark matter, dark energy, gas (in various ionization states), heavy elements, stars and black holes, starting from the glass-smooth state seen as the Cosmic Microwave Background, using the equations of gravity, hydrodynamics, radiation and nucleosynthesis.

The result is a model Universe representing galaxies, intergalactic gas and black holes. By comparing to state-of-the-art observations and identifying successes and failures of model predic-

tions, theorists like myself iteratively improve our models to better constrain the physical processes that give rise to galaxies and other cosmic systems.

The role of galaxy formation simulations in astrophysics has grown exponentially in recent times, owing both to their fidelity and range of applicability. They have emerged as an essential synergistic complement to observational studies. New billion-dollar telescopes such as the James Webb Space Telescope, while immensely powerful, are intrinsically limited to detecting only one portion of the electromagnetic spectrum. Simulations are required to assemble these multi-wavelength datasets into a coherent physical scenario for how the observed objects came to be. Today, virtually no large extragalactic survey project gets approved without a dedicated simulation modelling component.

Galaxy formation simulations have improved dramatically in their realism and sophistication over the past decade, driven by synergistic observations and ever-faster computers. Modern simulations utilise millions of CPU hours on leading supercomputers. The Illustris (U.S.), EAGLE (Europe) and my group's Mufasa (Africa) simulations, among others, now achieve unprecedented levels of realism.

We are constantly improving such simulations by employing a multi-scale approach to connect sub-parsec scale processes, such as star formation and

black hole accretion with megaparsec-scale structure driven by dark matter and dark energy. Despite impressive progress, the task remains far from finished. The daunting range of physical and temporal scales remains impossible to simulate simultaneously even on the world's largest supercomputers and it remains far from clear that we have identified (let alone understand) all the relevant physical processes for growing galaxies.

Perhaps the longest-lasting legacy of galaxy formation simulations is that they provide, for the first time, a full 3-D movie of how our Universe came to be. The impact of being able to visualise how galaxies like our own Milky Way and stars like our Sun emerged from the Big Bang cannot be overstated for both scientists and the general public. Combined with chemistry and biology that takes us from the formation of the Earth until human life today, we are closing in on completing humankind's first scientifically accurate story of our cosmic origins.



THE UNIVERSITY  
of EDINBURGH

**Prof Romeel Davé**  
**Chair of Physics**

The University of Edinburgh

Tel: +44 (0)131 668 8352

[romeeld@gmail.com](mailto:romeeld@gmail.com)

[www.roe.ac.uk/ifa/people/rad.html](http://www.roe.ac.uk/ifa/people/rad.html)

# Space: An essential sector for Europe at a time of digital revolution

Sebastien Moranta, coordinator of studies at the European Space Policy Institute (ESPI) explores why space is an essential sector for Europe during a time of digital revolution

The international space community recently celebrated the 60th anniversary of the launch of Sputnik 1 (October 4th, 1957), humankind's first step into the era of space exploration and use. In 60 years, humankind achieved many more steps (and giant leaps) in this field and space technologies progressed radically bringing forward new opportunities, but also new challenges to reap full benefits of what Ronald Reagan called the "New Frontier".

Satellites are nowadays enabling an incredible number of new applications across numerous sectors (i.e. defence, agriculture, energy, insurance, banking...), with ambitious plans on the horizon to connect the four billion unconnected people to the Internet or get a real-time view of the globe via constellations of hundreds of satellites.

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**"Beyond a rapidly growing industrial sector, the importance of space for Europe also rests on the considerable benefits that space-based solutions generate for European institutions, businesses and citizens, benefits that are often unsung and underestimated simply because the use of satellite, although pervasive, is often transparent."**

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Fostered by the digital revolution and stimulated by intense innovation and considerable private investments, a vibrant economy for the delivery of space-based services emerged and is growing rapidly, bringing into its wake the entire space industry. This renewed dynamism, often referred to as "New Space", is driving the space sector towards a more business- and service-oriented step and investors are confident that the global space economy, estimated in 2016 already around \$350 billion, will continue to grow substantially to reach \$1.1 trillion by 2040 according to the financial services firm Morgan Stanley and possibly

up to \$3 trillion by 2050, in the view of Bank of America Merrill Lynch estimations.

Thanks to a particularly efficient and competitive industrial base nested in European cooperation and to a fertile ecosystem for the development and adoption of space-based solutions, Europe counts today with key leaders of the space sector and captures more than 20% of global space markets. As a matter of fact, and despite a rather limited public budget in comparison to other spacefaring nations (0,1% of European public budgets – €12,5 per European citizen per year), space has become one of the rare high-tech sectors of European excellence.

Beyond a rapidly growing industrial sector, the importance of space for Europe also rests on the considerable benefits that space-based solutions generate for European institutions, businesses and citizens, benefits that are often unsung and underestimated simply because the use of satellite, although pervasive, is often transparent. Yet, space capabilities contribute actively to the economic development of Europe and support multiple efforts to tackle modern societal and environmental challenges.

It was recently estimated that more than 7% of the European Union Gross Domestic Product (GDP) depends, somehow, on satellite services with an economic benefit for the Union as large as €50 billion per year (Gross Value Added), supporting directly and indirectly about 1 million jobs in the Union. Space capabilities are also instrumental for the implementation of key European policies, including Common Agricultural and Fisheries Policies, the Energy Union or the Digital Agenda among many others.

Soon space capabilities will also become central com-





ponents of promising technologies embedded in the on-going digital transformation, such as 5G networks, precision agriculture and forestry, next-generation air traffic management systems, smart energy grids or autonomous vehicles, to name a few.

As summarised in the header of the Space Strategy for Europe issued by the European Commission in October 2016: “Space matters for Europe”.

In the digital revolution context, the space sector is undergoing a major transition and seems promised a bright future, yet, challenges ahead of the European space sector, including the industry, but also public institutions with the European Union on the frontline, are numerous and should not be underestimated. Recognising that stakes are high for the old continent and fully aware of the challenges ahead, the European Commission prepared an ambitious strategy identifying key areas of action to achieve Europe’s ultimate objective: improve, or at least maintain, its position on the global space scene and ensure that Europe reaps the full benefits of future developments in the space sector.

From a practical perspective, achieving this objective will be first and foremost a matter of resources and of political will to handle properly all challenges already identified, including those internal issues specific to Europe’s complex political set-up. Soon, the preparation of the next Multi-Annual Financial Framework of the Union will be a key milestone, which will earmark the resources that Europe is ready to commit to achieving its ambitious objectives. ■

**Sebastien Moranta**  
**Coordinator of studies**

European Space Policy Institute (ESPI)

Tel: +43 1 718 11 18 0

[office@espi.or.at](mailto:office@espi.or.at)

[www.espi.or.at](http://www.espi.or.at)

[www.twitter.com/ESPIspace](https://www.twitter.com/ESPIspace)



# 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

I put stress<sup>1</sup> 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.

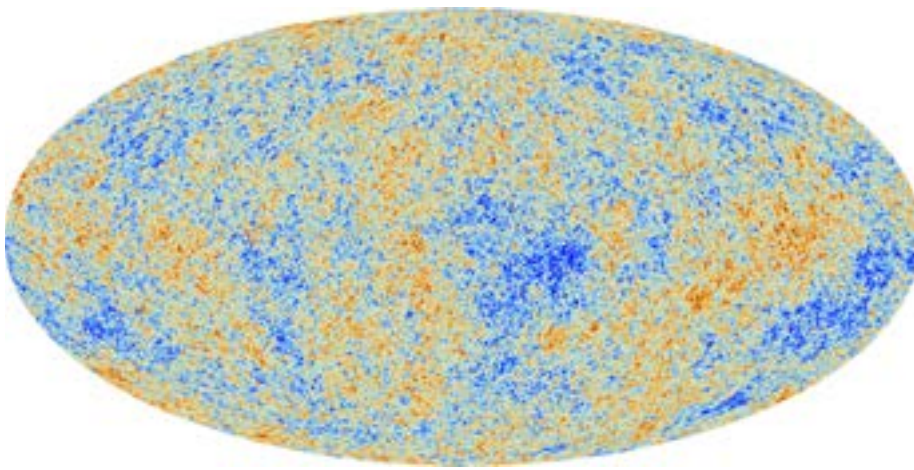
The APPEC Recommendations for the 2017-26 address specific scientific issues and updates of long-term scientific strategies, as well as societal issues like global collaboration, community building, gender balance, education, public outreach and relations with industry. Among these recommendations, there 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 macrocosmos.

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<sup>2</sup> use large detector arrays and reach high angular resolution.



*The CMB is the oldest light reaching us "here and now". The ESA/Planck observations of this light show tiny intensity fluctuations that bring information on regions that had slightly different densities when the universe was 380 000 years old. The existence of these regions explains the large scale structure of the universe we observe today*

Space-borne CMB measurements are not limited by the atmosphere and can probe a wide frequency range to provide an effective foreground subtraction to reveal the truly primordial B-modes induced by the primordial gravitational wave background.

The last space experiment dedicated to CMB observations is the ESA/Planck mission, which has created a CMB community in Europe with a unique expertise in space-borne CMB research. After the completion of Planck and the forthcoming Planck Legacy release, European CMB researchers have continued to play leadership roles in a number of suborbital efforts – both in Europe (e.g., Qubic, LSPE, Pilot) and elsewhere (e.g., by collaborating with the ground-based S4 program) – but still looking for a shared, major European experimental effort.

The European CMB community has also recognised the need and the urgency for a new space mission. There was quite a strong R&D effort in Europe in new technologies for the next generation CMB experiments and a proposal for a Core mission submitted to ESA has been, unfortunately, rejected. Therefore, LiteBIRD

(Lite satellite for the studies of B-mode polarisation and Inflation from cosmic background Radiation Detection) – a JAXA's strategic large mission candidate in Phase-A1 (concept development) – appeared to the European CMB community a natural and logical continuation of these Europe-led efforts.

At the national level, there is an interest to contribute to LiteBIRD from CNES in France, from both the UK Space Agency (UKSA) and the UK Science and Technology Facilities Council (STFC) and from the German Aerospace Center (DLR). The Italian Space Agency (ASI) has already founded the participation of the Italian CMB community to the LiteBIRD Phase A1 study, which will end by the end of this year.

Further interest at the European level has been manifested by Spain, the Netherlands and Finland, along with Sweden. To facilitate a coordinated effort of the European community during the Phase A1 of the LiteBIRD experiment, there is the willingness to constitute a European Consortium. The governance structure of this Consortium will be finalised during the forthcoming Turin Meeting (8th-

9th February 2018). This structure will be revised once the LiteBIRD mission will be approved and the so-called Phase B will start, early in 2019.

The participation of the European CMB community in LiteBIRD was solicited by a formal letter of the ISAS/JAXA Director-General. A potential junior partnership of ESA on the JAXA-led mission LiteBIRD could be realised through a Mission of Opportunity (MoO), if there is a clear scientific return to ESA's scientific community. However, ESA cannot approve a MoO before LiteBIRD is formally selected by JAXA.

So, while there is the need of not dispersing knowledge and skills acquired with the ESA/Planck mission, the formal selection from JAXA of the LiteBIRD mission seems to be the appointment not to be missed by the CMB European community.

See the link to my last book here, which was published in late 2017.

1 Open Access Government May 2017, pp 102-103

2 Open Access Government August 2017, pp. 182-183



**Prof. Nicola Vittorio**

Università degli Studi di Roma 'Tor Vergata'

Tel: +39 (06)72 594 581

[nicola.vittorio@uniroma2.it](mailto:nicola.vittorio@uniroma2.it)

<http://www.nicolavittorio.eu/en>

[www.web.uniroma2.it/home/newlang/english](http://www.web.uniroma2.it/home/newlang/english)

[www.cosmosnet.it/](http://www.cosmosnet.it/)



# Learning from the past: technologies from GM to big data

Katherine Mathieson, Chief Executive of the British Science Association explores what we can learn from the GM story when introducing new technologies

**H**ow do we get the public on board with big data? Technologies that have the power to improve our society can be rejected, because of the fears that they'll actually make society worse. Just before Christmas 2017, esteemed UK leaders gathered at the Huxley Summit to explore this problem.

Technology has the power to change our world, but it's not unstoppable. Public perception can pull the plug on science and its revolutionary potential. Despite a huge amount of scientific research into GM crops, their impact on human health and the environment, the public remains resistant to their widespread introduction to agriculture and industry.

What knowledge can be gleaned from the GM story? Going forward, what does it mean for the public, business leaders, scientists and policy-makers when new technologies are introduced? In exploring these questions, the Huxley Summit brought up some reflective, insightful and sometimes controversial ideas.

Journalist Evan Davis opened the Summit by asking: "why are certain lies more appealing to the public than other lies when a lot of lies are available?" Essentially, what he meant was: we believe what we want to believe. 20 years ago, there were scare stories about mobile phones frying our brains, but they didn't put us off buying them. We wanted to believe they were safe. We could see the



personal benefit of them. The opposite was true for GM. In their case, the benefits weren't communicated to, or seen by, the public. Hence their rejection.

But what about now? GM was the new technology of the 1990's. Today, we have big data. It's a huge player in the scientific world, but is already stirring up its own mistrust in the public psyche.

Uber's hacking scandal, which was shockingly revealed towards the end of last year, was a recent example of our personal data being stolen. However, what many saw as worse than the initial hack, was the unethical behaviour of the company that ensued – the subsequent cover-up. This kind of behaviour has a huge impact on how the public feels about technology and those that own it. It's no wonder then, that new research revealed at the Huxley Summit, showed that 73% of businesses are having to work harder to demonstrate trustworthiness. And trustworthiness goes hand in hand with acceptance.

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**“Technology has the power to change our world, but it's not unstoppable. Public perception can pull the plug on science and its revolutionary potential. Despite a huge amount of scientific research into GM crops, their impact on human health and the environment, the public remains resistant to their widespread introduction to agriculture and industry.”**

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Ben Taylor, Chief Innovation Officer of Assurance at EY, the Summit's headline sponsor, announced these figures after interviewing over 200 business leaders. EY also found that only 13% of businesses are on track to meet the key GDPR (General Data Protection Regulation) deadline, which is coming into force to keep our data safe and secure. This is a frighteningly low number and puts into question how seriously businesses are taking our privacy.

Chi Onwurah MP, also in attendance at the Summit, stated that there is no legal, ethical regulatory framework for data and that this should have been done five years ago. She accused the government of being completely “backwards looking” on the issue, believing that “the fall from grace we've seen with politicians and financial services will be nothing compared to the fall in trust we'll have with data.” She argued strongly that citizens and consumers should have total control and ownership of their own data.

Perhaps this is the crux of the argument. To gain public acceptance, scientists need to give the public a sense of ownership and fully communicate with them, with openness and transparency from the beginning. But this seemingly won't be easy.

Richard Thomas, a former UK Information Commissioner, alluded to us becoming a “nation of liars”. How many of us and how often, have ticked a box saying: “I have read, accepted and understood these terms and conditions”? He thinks that GDPR is going to be very detailed and very complicated and will be what he describes as “a lawyer's dream, a citizen's nightmare”.

It seems then that we need to learn from the past and tread with caution. Emerging technologies have the power to do so much good, but only when used in the right way. Data has been tremendously valuable – and it would be a shame for it to be rejected in the same way that GM was rejected in the EU. We must learn from negatives in the past, to gain positives in the future. We must communicate the benefits, give people a choice and a chance to change their minds, be open, have integrity and allow the public to have ownership. It is the public, after all, who are the most important aspect to all of this. ■



Image: © Thomas Alexander Photography

**Katherine Mathieson**  
**Chief Executive**

British Science Association  
Tel: +44 (0)20 7019 4935  
[katherine.mathieson@britishscienceassociation.org](mailto:katherine.mathieson@britishscienceassociation.org)  
[www.britishscienceassociation.org](http://www.britishscienceassociation.org)  
[www.twitter.com/BritSciAssoc](https://twitter.com/BritSciAssoc)



# Puzzled tribologist seeks contact with statistical physicist: Friction today

Julien Scheibert & Alain Le Bot at CNRS investigate the fascinating world of friction

**R**ecently found in the “Scientists” section of the dating ads: “I am a young tribologist (researcher in the field of friction). My ambition is to elucidate the mystery of the force resisting relative motion of bodies in contact, or friction force. My ancestor, Charles-Augustin Coulomb, discovered more than 200 years ago that the friction force is the product of the force pressing 2 solids into contact and the so-called friction coefficient.

However, we are still unable to predict the value of the friction coefficient of a given pair of materials. After years of investigations, I am convinced that the friction force is the sum of the forces acting on many micro-entities buried at the contact interface. Those are so numerous that I cannot count them one-by-one. This is why I seek a statistical physicist able to make sense of those large numbers. And maybe more...”

Tribologists ourselves, we share this vision of our research field. Macroscopic contacts are never single contacts. Consider for instance the contact between a car tire and a road (figure). It has the same typical size as a cell phone, but the road is rough and true contact only occurs close to the summits of centimetric pebbles. At the scale of pebbles, we discover new, smaller asperities forming the natural roughness of stone surfaces, at which individual micro-contacts are formed. At each step of zooming-in, down to

the scale of molecules, we discover that whatever appears to be a single contact is highly divided!

There is no doubt that the total friction force is simply the sum of all individual micro-contacts forces and that each micro-contact force is simply the sum of all associated molecular forces. “Simply”? Not quite. In practice, we do not know how to measure the individual forces on those micro-entities (neither micro-contacts nor molecules) within the confined interface between 2 solids. And even if we knew how, the number of micro-entities is so large that such measurements would take ages to be performed.

This is where statistical physicists enter the game. They know how to replace our large, inaccessible number of details on the actual contact with a statistical description in the form of a single, easily usable mathematical function named probability density. By doing so, the specifics that make the contact between this particular tire and that particular road unique are deliberately lost.

In contrast, one can now accurately describe the most probable behaviour of such a contact. This represents a change of paradigm in which the exact description of reality is replaced by a collection of possibilities and their probabilities. This approach also fits industrial needs, as it informs about the generic behaviour of a

series of products rather than that of a single one.

The use of such statistical approaches has already proved, in some particular cases, its explanatory power to connect friction behaviours at 2 different length scales. For instance, to relate the molecular scale to the micro-contact scale, Schallamach proposed a statistical model describing the velocity-dependence of the friction force of a rubber micro-contact as the attachment/detachment dynamics of rubber molecules on a track<sup>1</sup>. The model successfully explained the existence of a maximum friction force for a certain rubbing velocity.

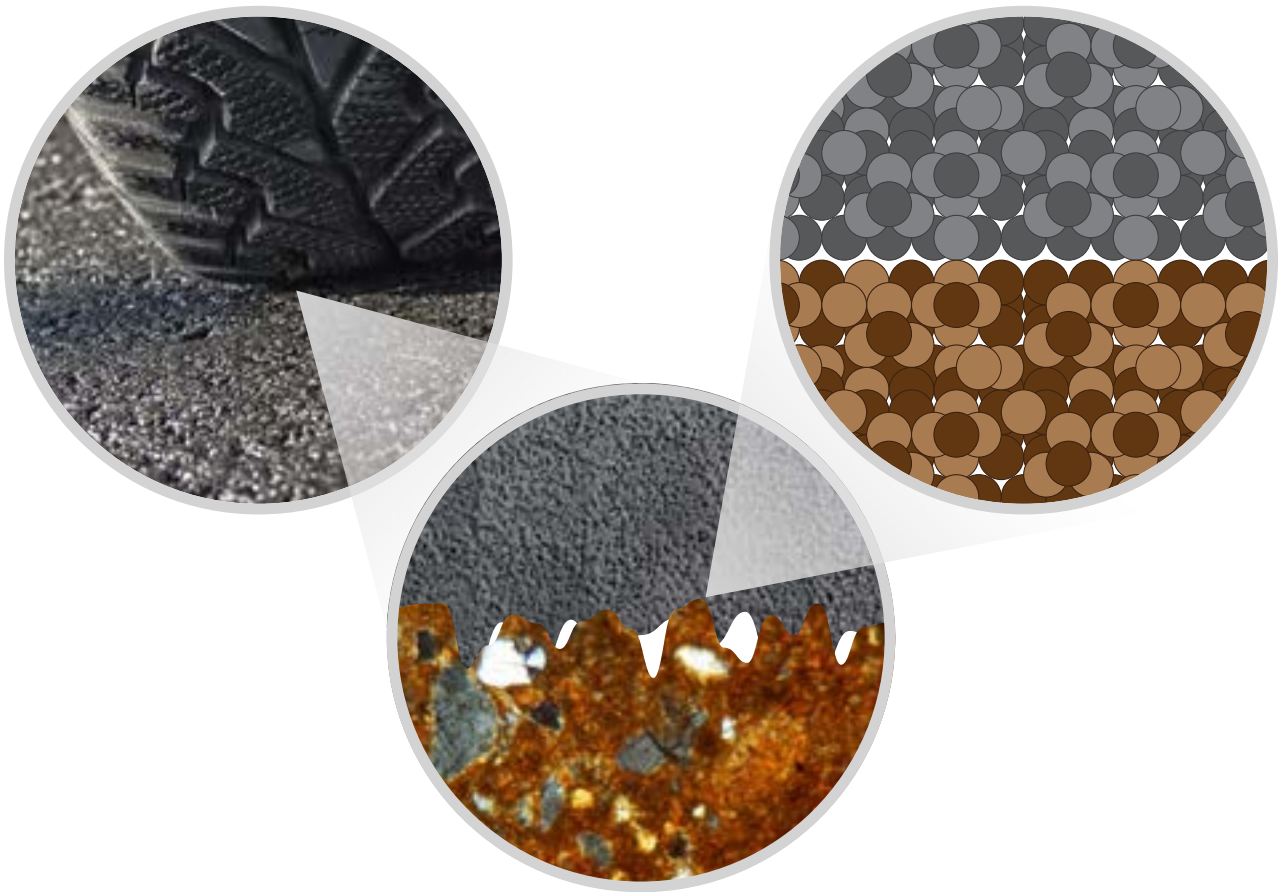
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**“After years of investigations, I am convinced that the friction force is the sum of the forces acting on many micro-entities buried at the contact interface. Those are so numerous that I cannot count them one-by-one. This is why I seek a statistical physicist able to make sense of those large numbers.”**

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A few years later, to relate the micro-contact scale to the macroscopic scale, Greenwood and Williamson described a rough elastic surface through a probability distribution of asperities’ heights<sup>2</sup>. By doing so, they showed that the area of real contact is proportional to the confining load applied to the interface, justifying the very existence of a friction coefficient.

In our own research, we follow the



footsteps of those visionary tribologists. For instance, we have proposed a statistical framework into which most Schallamach-inspired attachment/detachment-based friction models from the literature appear as particular cases<sup>3</sup>.

Even more interestingly, we managed to couple such a description of the interfacial friction with a realistic depiction of the bulk materials in contact. In other words, we have developed a multiscale model describing the behaviour of two solids in contact from the macroscopic scale of their shape and elasticity, down to the microscopic scale of the loading/sliding dynamics of individual micro-contacts. Such a powerful tool allowed us to reproduce and interpret unexplained experimental observations of the onset of sliding of a rough contact interface<sup>4</sup>.

In particular, we found that the contact between deformable solids does

not start to slide at the same instant everywhere along the interface. Just like in earthquakes, a portion of the interface starts to slip first (equivalent to the hypocentre), then grows and progressively invades the whole interface (equivalent to the seismic fault). We observed and explained the occurrence of very slow such invasions, reminiscent of the new class of slow earthquakes recently discovered, that one could qualify as “the dark matter of seismology”.

We claim that those successes in the field of friction have been made possible because tribologists managed to import and use some of the simplest tools developed by statistical physicists. Imagine now the breakthroughs that could be reached if statistical physicists would themselves bring the best of their knowledge and apply it to tribology! We wish our young tribologist the best for the dates to come. And maybe more...”

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### Julien Scheibert

#### Researcher

CNRS/Ecole Centrale de Lyon

[julien.scheibert@ec-lyon.fr](mailto:julien.scheibert@ec-lyon.fr)

[www.ec-lyon.fr/contacts/julien-scheibert](http://www.ec-lyon.fr/contacts/julien-scheibert)

Tel: +33 4 72 18 62 26

### Alain Le Bot

#### Researcher

CNRS/Ecole Centrale de Lyon

[alain.le-bot@ec-lyon.fr](mailto:alain.le-bot@ec-lyon.fr)

[www.ec-lyon.fr/contacts/alain-bot](http://www.ec-lyon.fr/contacts/alain-bot)

Tel: +33 4 72 18 62 75



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## Supporting research and new knowledge

Martin Ince discusses the Economic and Social Research Council's (ESRC) support for research and new knowledge

In April, the Economic and Social Research Council will become one of nine bodies making up a new organisation in British public life, UK Research and Innovation. One of its aims will be to deliver economic impact and social prosperity.

While “impact” is now an important consideration throughout UK research, it has always been a priority for ESRC. The ESRC produces new knowledge that is directly related to policy. It supports research in areas such as politics, business, education and economics, and has research initiatives in fields such as the EU, devolution and international development.

Since its establishment in 1965, ESRC has had the distinctive role of being a body which supports

research in the social and economic sciences on merit, with no regard for the political flavour of the day. Its awards have helped develop generations of social scientists who are now key thinkers in British society.

The annual ESRC Celebrating Impact Prize recognises outstanding ESRC research that has led to significant impact. Here's some examples. The British Election Study, which has looked at every UK general election for 50 years. Its analysis of the 2015 election, with its surprising win for the Conservatives, cast light on why polling had failed to predict the result. The answer, BES found, was that the people used in polling were not representative of the electorate. There is a definite ‘hard to reach’ group of voters who were not contacted and whose absence was not allowed for. A recalculation

tion allowing for these groups shows the Tories winning, as indeed occurred. It is notable that polling for the last year's general election did indeed show the gradual reduction in the Conservative lead over Labour with relative accuracy.

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**“In the era of cybercrime and people-smuggling, organised crime is one form of social organisation that we all want to see less of. Professor Mike Levi at Cardiff University has been funded by ESRC to look at money laundering, an essential service industry for serious crime.”**

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No issue has more political and emotional baggage in Britain right now than immigration, and the ESRC-funded Migration Observatory, run by Madeleine Sumption, has the essential role of putting some facts into a highly polarised debate.

It has shown that the popular impression of migrants coming “over here” to claim benefits is incorrect. Only 10-20% of EU immigrants get in-work benefits. For most, the attraction of the UK is the opportunity to work.

Researchers at the Observatory have also shed light on the contentious question of whether immigrants are putting stress on the housing market. They have shown that while 69% of the UK-origin population are homeowners, the figure falls to 42% for the foreign-born population. 80% of recent arrivals to the UK are in rented homes. However, immigrants are not using a disproportionate amount of social housing. 16% of the UK-born population and 17% of immigrants live in social housing.

The Observatory, based at the University of Oxford, has become a trusted source of insights such as this for the media and other stakeholders.

In the era of cybercrime and people-smuggling, organised crime is one form of social organisation that we all want to see less of. Professor Mike Levi at Cardiff University has been funded by ESRC to look at money laundering, an essential service industry for serious crime.

His work has shown that there is no evidence for the effectiveness of existing controls intended to prevent money-laundering. The reason could be that this a tough area to get hard data for. But he suggests that a “harm reduction” approach like that adopted for drug misuse might prevent illicit cash movements better than today's target-setting approach of counting arrests and cash seizures. He has also pointed to the key role of lawyers in illicit cash movements.

His work has fed into the UK organised crime strategy, and into legislation in Germany, as well as informing the European Commission directive on the confiscation of the proceeds of organised crime. ESRC's work is becoming steadily more international and involves deep collaboration with experts in other countries.

An example is work on HIV in Africa led by Professor Lucie Cluver in Oxford. Her team is working with colleagues in ten countries across Southern Africa to reduce the spread of HIV. Their research has informed the development of several Cash plus Care programmes in the region, including one which received \$385 million from USAID and the Bill and Melinda Gates Foundation. Paying younger girls cash avoids their need to bring money into the household via older men, and has been shown to reduce HIV in this age group by 60%. It works a lot better than the education-driven approach which has been in use for decades and which has had too little effect on infection rates.

As part of UK Research and Innovation, ESRC will continue to support research which tackles major social issues and makes a difference to people's lives around the world. ■

For more information about ESRC visit: [www.esrc.ac.uk](http://www.esrc.ac.uk)

**Martin Ince**  
**Science journalist and past president**  
**Association of British Science Writers**

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# Science, research and innovation in the UK

The role of the UK's Minister of State for Universities, Science, Research and Innovation is placed under the spotlight by Open Access Government

Recently appointed on 9th January 2018 as Minister of State at the Department for Transport and Minister for London, Jo Johnson was previously the Minister of State for Universities, Science, Research and Innovation, from July 2016 to January 2018. He was also elected Conservative MP for Orpington in May 2010 and re-elected in May 2015.

Outside of his political career, Johnson joined the Financial Times in 1997, after working as an investment banker at Deutsche Bank. He had two foreign postings with them: firstly, as Paris correspondent (2001 to 2005) and then as South Asia Bureau Chief based in New Delhi (2005 to 2008). In 2008, he became an associate editor of the Financial Times and Head of the Lex Column.

Johnson's future ministerial responsibilities will be confirmed in due course, during his role within transport and as Minister of London. He will control policy relating to London, including informing Members of Parliament in the House of Commons on the activities of the Greater London Authority.

He will also be taking over from MP Greg Hands, who served as minister for London from 13th June 2017, until Theresa May's recent Cabinet reshuffle. Theresa May has said her reshuffle makes the government look "more like the country it serves" with a "new generation" of ministers brought in.<sup>1</sup> This is backed up by Johnson's replacement for universities minister, Sam Gyimah. Currently age 41, Gyimah will work alongside the newly appointed Education Secretary, Damian Hinds, who replaces Justine Greening.

As Minister of State for Universities, Science, Research and Innovation, Johnson was responsible for everything from Industrial Strategy to intellectual property, including:

- Universities and higher education reform (including implementation of the Higher Education and Research Act and teaching excellence framework and quality);
- Higher education student finance (including the Student Loans Company);
- Widening participation and social mobility;
- Education exports (including international students, international research);
- Science and research, including the creation and governance of UK Research and Innovation (UKRI);
- Agri-tech;
- Space and;
- Innovation.

These are the areas that Gyimah will be covering during his time as Minister. During 2017, Johnson was involved in many topical contracts, particularly in the space sector. November 2017 marked the signing of the 2020 climate change mission contract between Thales Alenia Space and the UK Space Agency. It will work on MicroCarb, a joint UK-French satellite mission, which will measure sources and sinks of carbon, the principal greenhouse gas driving global warming. It is the first European mission intended to characterise greenhouse gas fluxes on the Earth's surface and gauge how much carbon is being absorbed by oceans and forests.

Minister Johnson, spoke on a visit to Thales Alenia Space's Belfast facility and stated that the UK space sector is currently brimming with talent. Added to this,

the collaboration with France on MicroCarb is an excellent platform to demonstrate the UK's cutting-edge science and engineering, which is at the core of the UK's Industrial Strategy.<sup>2</sup>

Johnson also commented on the amount of the investment (funded by the UK government's Industrial Strategy Challenge Fund) and the hopeful benefits it will bring, which he described as follows: "It is great to see our £99 million investment in the new National Satellite Test Facility is already making a difference for the sector. This facility will make Harwell a world-class hub for innovative space technology, helping UK companies like Thales Alenia Space be more competitive in the global market and support our ambition to capture 10% of the global space market by 2030."<sup>3</sup>

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**"November 2017 marked the signing of the 2020 climate change mission contract between Thales Alenia Space and the UK Space Agency. It will work on MicroCarb, a joint UK-French satellite mission, which will measure sources and sinks of carbon, the principal greenhouse gas driving global warming. It is the first European mission intended to characterise greenhouse gas fluxes on the Earth's surface and gauge how much carbon is being absorbed by oceans and forests."**

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Furthermore, in October 2017, Johnson announced the news of an initial £3 million awarded for UK leadership of new space science mission SMILE, (the Solar Wind Magnetosphere Ionosphere Link Explorer). It will support academics working on the mission, helping to address fundamental gaps in knowledge of the solar-terrestrial relationship by providing, for the first time ever, global imaging of the Earth's magnetosphere and its dynamic response to solar wind – charged particles streaming from the Sun.

One more thing to acknowledge during Johnson's time as Minister is his announcement of the first ever two winners of the Newton Prize 2017 during a two-day trip to India. He outlined the strength of collaboration with Indian partners and the UK's ambitions to develop the relationship further. During the visit, Jo Johnson even announced further research agreements securing further collaboration between the two countries, rather than just stating it.

Elaborating on this point, he said: "These Newton Prize winners not only embody international collaboration on crucial issues, but also illustrate our ambition to work with our global partners on a wide variety of mutually-beneficial research."<sup>4</sup>

Looking to the future, Sam Gyimah will certainly take on an important role for the following year, indeed he has already publicly announced both his thanks and gratitude to Johnson for his previous work and also the prisons and probation staff that he worked so closely with last year during his role as prisons minister, as he explains in his own words on Twitter: "Off to my new role as Universities & Science Minister and looking forward to the challenges ahead – thank you for your excellent work @JoJohnsonUK. A massive thank you to all prisons & probation staff, particularly prison officers, for your incredible dedication & hard work."<sup>5</sup>

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# Integrating nanomaterials safety data so that it is Findable, Accessible, Interoperable and Re-usable

Professor Iseult Lynch from University of Birmingham, School of Geography, Earth and Environmental Sciences explores the amazing opportunities offered by nanotechnologies

Nanotechnologies and the ability to manipulate matter at the nanoscale (1-100nm) have opened up amazing new opportunities for industry and consumers. Nanotechnology has been identified as a key enabling technology (KET), providing the basis for further innovation and new products. 2012 estimates suggested that nanotechnologies account for up to 400,000 jobs in the EU, with an increasing tendency.<sup>1</sup>

Innovation in both novel and emerging materials is central to enhancing European industrial competitiveness, but as part of a responsible innovation strategy, novel material development must proceed in parallel with an assessment of their environmental health and safety. This has been embedded into the Commission's [code of conduct for responsible nanotechnologies](#), published in 2009.

Despite 10+ years of nanosafety research, the consensus among experts and regulators alike is that there is insufficient data available to perform a risk assessment of both nanomaterials and nano-enabled products.<sup>2</sup> To a large extent, this impasse is due to the lack of a common home or repository for the datasets generated by researchers and the lack of consensus around minimal reporting guidelines and metadata. The three

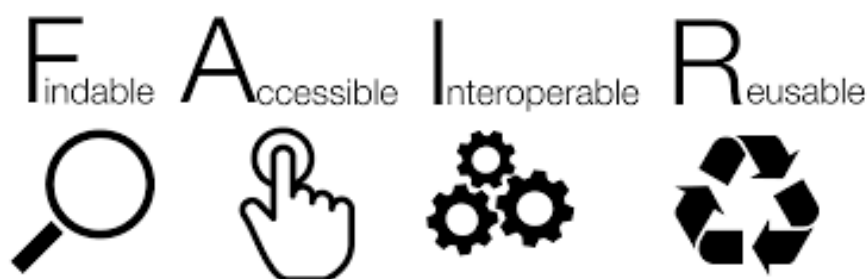


Figure 1: Schematic representation of the principles of FAIR data

to four-year cycle of EU project funding has resulted in 50+ projects having addressed nanosafety over the period 2005-date, with at least 15 running currently under Horizon 2020.

While the projects do make a concerted effort to pass on learnings and findings from one to the next, facilitated via the [EU NanoSafety Cluster](#) of projects, the physical and virtual transfer of underpinning datasets has not been achieved as yet. Even where data are deposited in a database (such as the [eNanoMapper database](#), developed and maintained by the SME IdeaConsult via their participation in successive H2020 grants, such as NanoReg2), they are often restricted only to other project users, require a formal agreement to be established between projects to allow access, or are not appropriately curated and quality controlled so as to be immediately useful. In short, much of the existing data on nanomaterials safety does not comply with the goals of Open and FAIR data, i.e., data that is

Findable, Accessible, Interoperable and Re-usable (see Figure 1).

The goal of the NanoCommons e-infrastructure project is to develop the community guidance and best practice to support EU nanosafety projects with their data management. The ultimate goal is to ensure that nanosafety data, old and new, is accessible to scientists for the development of computational hazard and risk assessment models, for the nanotechnology industry to support product development and safe-by-design approaches and for regulators (via the [European Observatory for Nanomaterials](#)) for science-based decision making.

This €5.2 million project, coordinated by Prof. Iseult Lynch, brings together 12 European partners (five of whom are small to medium enterprises) and two US partners involved in the harmonisation of nanosafety data approaches there, to integrate and enhance the FAIRness of the currently

**Transnational Access for users to:**  
 KnowledgeBase integrating data & tools  
 Ontology services  
 Data processing & import services  
 Data mining tools  
 Omics metadata support  
 Predictive tools  
 Visualisation / Risk tools  
 Nanoinformatics Workflows for key experiments

6-monthly calls for Users – external peer review



disparate nanosafety datasets generated from EU projects and to secure a platform for EU (and international) nanosafety data in the future.

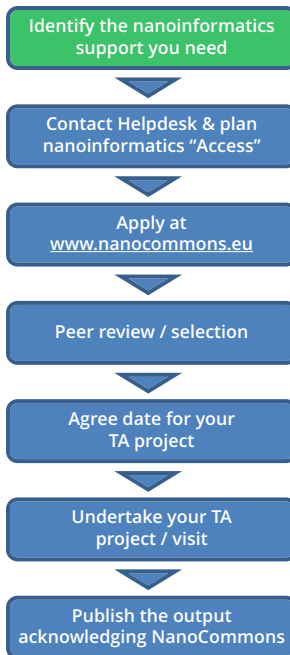
As part of the international strategy, the NanoCommons project partners include the Centre for Environmental Implications of NanoTechnologies at Duke University, who have been developing a cyberinfrastructure consisting of a data repository and associated analytical tools. These have been developed to visualise and interrogate integrated datasets ([CEINT Nanoinformatics Knowledge Commons](#), NIKC) and Oregon University, who have developed the [Nanomaterial-Biological Interactions Knowledge-base](#), a repository for annotated data on nanomaterial characterisation, synthesis methods and nanomaterial-biological interactions (beneficial, benign or deleterious) defined at multiple levels of biological organisation (molecular, cellular, organismal).

As an infrastructure project, NanoCommons has activities grouped into three distinct pillars – joint research to develop the templates and tools for data management, networking activities to build community

consensus and support adoption of the tools and templates and provision of transnational access to the broader user community to support them in their utilisation of the tools, such as generation of quantitative structure-activity relationships based on users datasets, or application of curation tools to integrate user data into the knowledge warehouse.

A very strong focus for the project will be the development and integration of nanoinformatics work-flows into researchers' experimental procedures, such that data management that becomes an integral part of data generation and interpretation. The utilisation of e-notebooks, laboratory information management systems and other emerging data management approaches, linked to bespoke data capture templates embedded in the agreed [nanosafety community ontologies](#) (which NanoCommons will also support the community to develop further), are central goals of the project.

Transnational access (which can be remote or physical) will be facilitated by six-monthly calls for users/user-defined projects and all of the networking activities will be open to the



whole nanosafety and nanomaterials communities, including researchers, industry, regulators and the wider societal stakeholders such as NGOs, insurers, funding agencies, publishers, policy makers and science communicators. A suggestion box and request for tools to develop/integrate will be available throughout the project and a help-desk for users will be available to support the community in their data management activities.

Thus, the user community is central to the success of NanoCommons, as unless the tools and approaches are adopted by the wider research community, including funding agencies and publishers, they won't reach the critical mass of acceptance required for uptake by regulators and industry.

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UNIVERSITY OF  
BIRMINGHAM

**Professor Iseult Lynch**  
**Chair of Environmental**  
**Nanosciences/Professor**  
 University of Birmingham,  
 School of Geography, Earth and  
 Environmental Sciences  
 Tel: +44 (0)121 4145 532  
[i.lynch@bham.ac.uk](mailto:i.lynch@bham.ac.uk)  
[www.birmingham.ac.uk/schools/gees/people/profile.aspx?ReferenceId=56477](http://www.birmingham.ac.uk/schools/gees/people/profile.aspx?ReferenceId=56477)  
[www.twitter.com/iseult5](https://twitter.com/iseult5)



# Advancing the frontiers of computing

Erwin Gianchandani and Michal Ziv-El from the National Science Foundation (NSF) provide a fascinating insight into how fundamental computing research is profoundly transforming our lives

From cybersecurity to autonomous vehicles and assistive robotics, investments by the National Science Foundation's (NSF) CISE directorate have resulted in myriad breakthrough technologies over the last several decades that in turn have profoundly transformed our lives, addressed national priorities and driven economic competitiveness.

For example, in the mid-1990s, Google co-founders Sergey Brin, a former NSF Graduate Research Fellow and Larry Page, whose work was supported through an NSF Digital Library Initiative grant, created the "page-rank" algorithm that would become the basis for their groundbreaking search engine.

Around the same time, NSF-funded researchers at the Massachusetts Institute of Technology (MIT) developed algorithms to quickly deliver content via a geographically-distributed network of servers, reducing Internet congestion. This work launched a multi-billion-dollar industry and two members of the research team founded Akamai Technologies. Akamai is now valued at \$10 billion and routes between 15 and 30% of the world's Internet traffic.

Today, NSF's CISE directorate aims to continue to advance the frontiers of computing, thereby enabling

America to uphold a position of world leadership in computer, communication and information science and engineering; promoting understanding of the principles and uses of advanced computing, communications and information systems in service to society; supporting and providing advanced cyberinfrastructure to enable and accelerate discovery and innovation across all science and engineering disciplines; and contributing to universal, transparent and affordable participation in an information-based society.

To achieve these goals, CISE supports investigator-initiated research in all areas of computer and information science and engineering; helps develop and maintain cutting-edge cyberinfrastructure to enable research and education across all fields of science and engineering; and contributes to the development of a computer and information technology workforce with skills essential for success in an increasingly competitive global market.

In the recently-completed fiscal year 2017, CISE awarded more than 1,800 grants with a budget of \$936 million, supporting nearly 18,000 people including faculty, postdoctoral researchers and graduate and undergraduate students. Furthermore, about 83% of all federally-funded fundamental, academic computer

science research was supported by NSF in the fiscal year 2017 and most of that through CISE.

The CISE directorate is organised into four primary units. The Division of Computing and Communication Foundations (CCF) advances computing and communication theory, algorithms for computer, computational and information sciences and architecture and design of software and hardware systems. The Division of Computer and Network Systems (CNS) invents new computing and networking technologies, while ensuring their security and privacy and finds new ways to make use of existing technologies.

The Division of Information & Intelligent Systems (IIS) studies the interrelated roles of people, computers and information to increase the ability to understand and harness data, as well as mimic the hallmarks of intelligence in computational systems through advances in artificial intelligence, computer vision, robotics, machine learning, natural language processing, computational neuroscience, cognitive science and related areas.

And the Office of Advanced Cyberinfrastructure (OAC) supports and coordinates the development, acquisition and provision of state-of-the-art cyberinfrastructure resources, tools and services essential to the advancement and transformation of all fields of science and engineering. Each CISE division/office comprises a number of programmes that collectively fund a portfolio of grants spanning a broad range of research, research infrastructure and education activities.

CISE-supported activities are aligned with emerging national challenges – and also with a set of 10 bold, long-term research and process “Big Ideas” that identify areas for future investment at the frontiers of science and engineering. For example, recent grants through the Transdisciplinary Research in Principles of Data Science (TRIPODS) program, co-led by CISE and NSF’s Directorate for Mathematical and Physical Sciences, aim to bring together computer scientists, mathematicians and statisticians to develop better data mining and machine learning approaches and enhanced visualisation techniques.

The TRIPODS awards are aligned with NSF’s Harnessing the Data Revolution for 21st-Century Science and Engineering Big Idea, which aims to advance fundamental research in data science and engineering; the develop-

ment of a cohesive, federated, national-scale approach to research data infrastructure; and the nurturing of a 21st-century data-capable workforce.

Similarly, the almost decade-long Cyber-Physical Systems (CPS) program, led by CISE in partnership with NSF’s Directorate for Engineering and six other federal agencies, funds research that is integrating physical infrastructure, such as transportation networks and the energy grid, with “cyber” capabilities to yield new jobs and contribute to economic growth in cities and communities all across America.

CISE is also building the knowledge base for rigorous, engaging computer science education that can be accessed by all Americans: CISE co-funded with NSF’s Directorate for Education and Human Resources the development of a new Advanced Placement® (AP®) Computer Science Principles (CSP) framework and exam; more than 50,000 students took the first offering of the AP CSP exam in spring 2017, making it the largest single exam launch in the AP program’s 60-year history and the exam also saw enhanced diversity among the test takers.

It’s an exciting time to be in computer science! Computing is everywhere, touching all fields of science and engineering and impacting all facets of society – and it’s continuing to rapidly expand and evolve. As with Google and Akamai decades ago, sustained investments in fundamental research, research infrastructure and education by NSF’s CISE directorate today are powering the technological breakthroughs that will transform society for tomorrow. ■

**Erwin Gianchandani, PhD**  
**Deputy Assistant Director**

Directorate for Computer and Information Science and Engineering  
National Science Foundation (NSF)

**Michal Ziv-El, PhD**  
**American Association for the Advancement of Science**  
**(AAAS) Science & Technology Policy Fellow**

Directorate for Computer and Information Science and Engineering  
National Science Foundation (NSF)

Tel: +1 703 292 5111

[info@nsf.gov](mailto:info@nsf.gov)

<https://www.nsf.gov/dir/index.jsp?org=CISE>

[www.twitter.com/NSF](https://www.twitter.com/NSF)

# AR Controllers for 6-Degree-of-Freedom Interaction

Zeyuan Chen and Christopher G. Healey from North Carolina State University reveal their institution's expertise on virtual and augmented reality (VR and AR) systems

**V**irtual and augmented reality (VR and AR) systems provide more immersive experiences for users to explore and interact with the three-dimensional (3D) world, versus traditional display devices like monitors. One of the essential parts of VR/AR systems is their controllers, which are responsible for manipulation of 3D information.

For instance, users may want to inspect computer-aided design (CAD) models from different angles or control video game characters naturally and intuitively. 3D interaction tasks such as rotation and docking are challenging with conventional 2D input devices. Six Degree of Freedom (6DoF) input devices tend to be more effective, but are also difficult to design.

There are a variety of 6DoF devices available that roughly fall into two groups: camera based and non-camera based systems. There has been extensive work on developing 6DoF devices using visible light or infrared camera data, such as the video mouse, SideSight, and HoverFlow. This group of controllers are mostly free-moving devices since they allow users to manipulate 3D information through the rotation and translation of the controllers in free space.

It is generally very easy and natural to learn to use a free-moving device because of the direct mapping from the absolute pose of the device to the

virtual objects. But, this kind of device is generally very complex to design. For instance, each HTC Vive controller contains 24 sensors and must be tracked by two external base cameras for accurate pose estimation.

An alternative is to build an input system with a single camera, which is much cheaper than other sensor-based or multi-camera systems. However, the design is more challenging. Many systems require only regular RGB cameras. For instance, MagicMouse and ARToolKit estimate pose by tracking monochrome 2D markers, which work well if the rotation range is within 180 degrees. Some other approaches make use of colour information to achieve better performance and can track rigid (e.g. cubes) and non-rigid bodies (e.g. hands) with high accuracy and low latency.

Another branch of research uses RGB plus depth (RGBD) images captured by devices like the Microsoft Kinect as input for tracking, but they are often unable to achieve high accuracy because of the relatively low precision of the depth cameras.

Of the wide range of non-camera based controllers, desktop isometric devices are the most common. For instance, 3Dconnexion's SpaceNavigator is a desktop 3D mouse that allows users to manipulate 3D objects by controlling its pressure-sensitive handle.

Unfortunately, users often need significant practice and training, up to several hours, before they are comfortable with this type of device.

Another popular branch of non-camera based controllers are cube-based systems, which use embedded sensors and provide tangible user interfaces. The advantage of this type of device is that the cubes can be aligned with flat surfaces in a stable way and 3D cardinal directions can be recognised more easily in the cube coordinate system.

VR and AR systems are providing new ways to view and manipulate 3D objects. One of the essential problems is to design efficient, accurate, yet affordable controllers. Some basic interaction tasks like 3D object rotation are challenging with conventional 2D input devices. 6DoF devices are much more effective for 3D information manipulation. However, popular 6DoF devices are often hard to use, expensive and suffer from high latency or low accuracy.

We have developed a tangible 6DoF input device that is cheap and natural to use to support manipulation of 3D information [CHA17]. The system includes a single RGB camera and a 3D-printed wireframe cube (Figure 1). The pose of the cube is estimated with computer vision algorithms so that when the cube is translated or rotated by the user, the 6DoF information changes to follow.



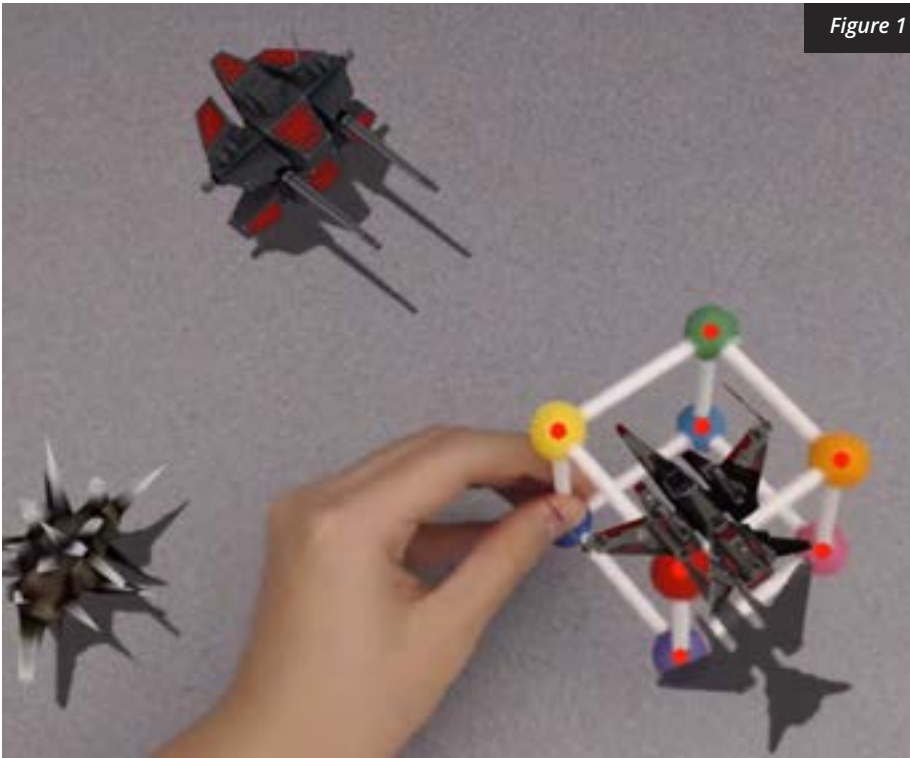


Figure 1

Figure 1 shows an example of using our device for AR game design. When a user translates or rotates the physical cube, the virtual object (e.g. the fighter) changes to follow; see the online video demonstration at <https://youtu.be/gRN5bYtYe3M>.

**“VR and AR systems are providing new ways to view and manipulate 3D objects. One of the essential problems is to design efficient, accurate, yet affordable controllers.”**

The processing pipeline consists of two phases: location and estimation. In the location phase, the minimum region that covers the cube is detected based on the overall shape of the cube, as well as correlation between video frames. In the estimation phase, the accurate locations of cube corners are computed and recognised based on colour. The pose of a cube is estimated by solving the correspondences of the detected corner coordinates and the pre-defined mathematical model of the cube, which is known as the Perspective-n-Point (PnP) problem.

Evaluated by several experiments, our device has shown important improvements over existing controllers. Our frame rate is 63.75 frames per second (FPS) on average and the mean estimation error is only one degree. In standard virtual object matching experiments, users needed only 2.79 seconds to finish one rotation task with our device, which represents the best performance so far for similar experiment settings.

Our system works robustly in various challenging environments. Firstly, we have developed an automatic lighting adjustment system and carefully chosen the colour model so that even dramatic changes in lighting do not affect the performance of our device. Secondly, the system is insensitive to occlusion. Up to four corners can be occluded under the condition that only a slight drop in accuracy is tolerated. Thirdly, our device is insensitive to background clutter and noise, even when some of the background objects have similar shapes or colours to the cube corners.

It is very simple to integrate our device with other display systems, such as stereo Fish Tank Displays, desktop environments and so on. The setup process is also very simple. Users need only install a regular camera (which is already available on most laptop or tablets), build the cube, install our software and run through a few automatic calibration steps. It requires almost no training to use our device since it is basically the same as interacting with a physical object.

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**NC STATE  
UNIVERSITY**

**Zeyuan Chen**

**Ph.D. Candidate**

Computer Science Department,  
North Carolina State University

Tel: +1 607 379 8335

[zchen23@ncsu.edu](mailto:zchen23@ncsu.edu)

[zeyuanchen.com](http://zeyuanchen.com)

[www.twitter.com/zeyuanchen](https://twitter.com/zeyuanchen)

**Christopher G. Healey**

**Professor**

Department of Computer Science  
Goodnight Distinguished Professor,  
Institute for Advanced Analytics  
North Carolina State University

Tel: +1 919 515 3190

[healey@ncsu.edu](mailto:healey@ncsu.edu)

<http://go.ncsu.edu/healey>

[www.twitter.com/chris.g.healey](https://twitter.com/chris.g.healey)



# The changing face of Heterocyclic Chemistry in the pharmaceutical industry

Professor of Organic Chemistry at 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 2017, the Royal Society of Chemistry's Heterocyclic and Synthesis Group celebrated its 50th anniversary. It thus appears timely to consider how the role of heterocycles in the development of pharmaceutical drugs has evolved over the last 50 years.

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.<sup>1</sup>

In chemical terms, heterocycles are cyclic compounds containing at least one non-carbon atom, typically nitrogen, oxygen or sulfur. They come in two flavours: heteroaromatics such as pyridine where the heterocycle also has an aromatic, benzene-like structure, and saturated, non-aromatic like the commonly used solvent tetrahydrofuran.

Why are heterocycles so common in pharmaceuticals? 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 sulfur atoms, whether heteroaromatic or not, offer excellent opportunities for hydrogen bonding 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.

When the Royal Society of Chemistry's Heterocyclic Group started in 1967, most of the interest was in relatively simple heteroaromatic compounds and, in particular, in the search for new ring types – different ring sizes and different, or often simply more, heteroatoms. This interest was mirrored by researchers in pharma-

ceutical companies who became very interested in the new intellectual property space afforded by novel heterocyclic scaffolds.

Aside from the development of the beta-lactam antibiotics, which are still going strong (e.g. amoxycillin), the pharmaceutical industry was mostly interested in flat, 2-dimensional heteroaromatic heterocycles. To some extent, this has been compounded by the introduction to the synthetic community of the Nobel prize-winning Suzuki-Miyaura cross-coupling reaction, which is an efficient way of coupling two heteroaromatic rings. As a result, up until around ten years ago, there was a great focus in the pharmaceutical industry on heteroaromatic-based heterocyclic drugs.

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**“Over the last 5 years, there has been a shift away from small-molecule drugs to the use of so-called biologics, which are pharmaceutical drugs manufactured in, extracted from or semi-synthesised from biological sources. Examples include vaccines, gene therapies and recombinant therapeutic proteins. Indeed, of the top 10 best-selling drugs of 2016, eight are biologics.”**

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However, the last ten years has seen a shift in direction for heterocycles in pharmaceutical drug development. There has been a growing interest in the use of 3-dimensional, non-aromatic heterocycles in drug discovery. A paper entitled “Escape from Flatland”<sup>2</sup> highlighted the fact that 3-dimensional drug molecules performed better than 2-dimensional ones through the whole drug discovery process, which may be due to an associated better solubility profile.

3-dimensional heterocycles have thus become a popular design feature in the pharmaceutical industry and



**Professor  
Peter O'Brien**

this has spurred on academic groups to develop new methods for the synthesis of 3-dimensional heterocycles. For example, one part of a European Union-funded project entitled the “European Lead Factory”<sup>3</sup> focuses on the synthesis of novel, lead-like drug molecules for incorporation in a many-thousand compound library. A number of publications have now appeared from this project and it is clear that scaffold novelty and 3-dimensional heterocycles are key design criteria.

The use of these 3-dimensional scaffolds is not without its issues, however, as carrying out structure – activity studies by changing different parts of the compound and studying its biological activity is generally much harder than with 2-dimensional heteroaromatics. The academic and industrial synthetic community is attempting to meet this challenge head-on with the development of numerous new chemical transformations that had previously been deemed impossible. Research in areas such as sp<sup>3</sup>–sp<sup>2</sup> and sp<sup>3</sup>–sp<sup>3</sup> cross-coupling, photo-redox catalysis, CH activation and late-stage functionalisation is booming and has enabled improved functionalisation of both 2- and 3-dimensional heterocycles.

The nature and chemical structure of heterocycles in pharmaceutical drug development are also changing. The search for new scaffolds and new approaches to controlling drug properties such as metabolism and solubility has led to the use of some more unusual 3-dimensional heterocycles. For example, 4-membered ring heterocycles including oxetanes<sup>4</sup> and azetidines have become commonplace in medicinal chemistry programmes. As well as exploring smaller ring sizes, larger ring sizes have become particularly popular in drug discovery, especially macrocyclic heterocycles – cyclic heterocycles containing 12 or more atoms in the ring. An example is the recently marketed drug

Simeprevir, which is used to treat the Hepatitis C virus. Macrocyclic drugs are also proving particularly useful in treating diseases where disrupting protein – protein interactions is crucial.

Finally, over the last 5 years, there has been a shift away from small-molecule drugs to the use of so-called biologics, which are pharmaceutical drugs manufactured in, extracted from or semi-synthesised from biological sources. Examples include vaccines, gene therapies and recombinant therapeutic proteins. Indeed, of the top 10 best-selling drugs of 2016, eight are biologics. Although biologics contain large, protein-sized molecules, if you look hard enough you will find numerous examples of heteroaromatic and non-heteroaromatic heterocycles in these drugs! ■

Professor Peter O'Brien is Professor of Organic Chemistry at the University of York, U.K. and is currently the Chairman of the Royal Society of Chemistry's Heterocyclic and Synthesis Group. His group researches the development of new methods for the synthesis of 3-D heterocycles.

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**Professor Peter O'Brien**  
**Professor of Organic Chemistry, University of York, U.K**  
**Chairman of the Royal Society of Chemistry's Heterocyclic and Synthesis Group**

peter.obrien@york.ac.uk

[www.rsc.org](http://www.rsc.org)

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# Get your medicinal chemistry right!

Prof Colin J Suckling from the University of Strathclyde gives his opinion on getting your medicinal chemistry right to gain success in the field

One of the pillars of interdisciplinary research at the University of Strathclyde concerns all aspects of health and well-being. For chemists, this means medicinal chemistry. As many of our medicinal chemistry projects move positively ahead towards the clinic, I am reminded of the multiplicity of factors that must be optimised to obtain a successful drug molecule. We've got to get them right in our research projects and train our students to deal with them all in our courses.

The front-runner is our new antibacterial compound for the treatment of *Clostridium difficile* associated disease is now ready for a Phase II clinical trial to be managed by our commercial

partner, MGB Biopharma. A little behind this is our search for a new treatment for African Animal Trypanosomiasis that would make a huge difference to millions of people and cattle in sub-Saharan Africa; we have proved the effectiveness of our new drugs in animal models of the disease.

**“Interestingly... finding the target in the body and the dose form have been harder to get right than just the binding to the target itself.”**

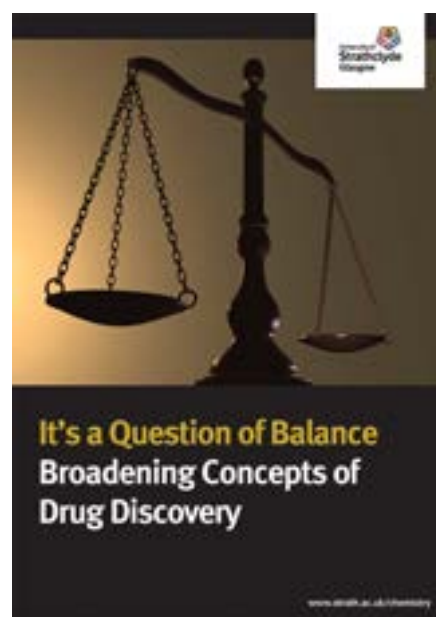
In another field, our search for a novel treatment for refractory prostate cancer led by my colleague, Professor Simon Mackay, has reached the stage in which our lead compound has been shown to inhibit the growth of prostate cancer in animal models of the disease. These are substantial steps forward.

## Drug trials

In these cases, and virtually every other case, the drug, which in our work is almost always a small heterocyclic compound, must bind to a large molecule in the body, usually called the target. Binding causes either the stimulation or the blocking of a natural function related to the disease state, hopefully leading to a beneficial effect on the patient.

I've described this process of drug and target and how heterocyclic chemistry

makes it work in a series of e-books for Adjacent Digital Politics Ltd (see below).



Thomas Graham Building at the University of Strathclyde housing part of the Department of Pure & Applied Chemistry



*Teaching laboratory in action in the Department of Pure & Applied Chemistry, University of Strathclyde.*

The essence of it is that if the shape and size of the drug molecule are right with respect to the target, in other words, if it fits the target, the therapeutic effect will be obtained. This depends on very detailed and specific chemical bonding between the drug and its target. A single atom of the wrong element in the wrong place or a single atom too many can be the difference between an active and an inactive compound, between success and failure. Medicinal chemistry is concerned with sorting out these details and finding compounds that do what you want them to do at the target.

If that were all, discovering a new innovative drug would be easy. Obviously, though, if the drug does not reach the target, nothing will happen. Imagine a drug in a pill taken by mouth. The drug molecule must survive digestion and find its way into the blood stream. It must avoid being destroyed by the liver and excreted rapidly through the kidneys remaining in the blood to find its target. These attributes are much harder to design in from the start, although there are some good rules of thumb to follow. Stability to survive digestion and the

liver depends upon chemical reactivity that is predictable but you're never quite sure what will happen when a drug gets into a patient.

Finding the way to the target depends upon the physicochemical properties of the drug molecule, in particular, its solubility in water and its acidity. Solubility and stability also influence whether the drug can be given orally and whether it can be given once a day or requires many doses per day. Interestingly in our own projects mentioned above, finding the target in the body and the dose form have been harder to get right than just the binding to the target itself.

## **Different types of chemistry**

Indeed, it's quite a package to get right because it requires considering synthetic chemistry, chemical reactivity, and physical chemistry. This is why at Strathclyde we like to teach as much of the basic chemistry as we can in the context of its applications, such as medicinal chemistry.

In drug discovery research, different approaches are taken by different research teams. At the University of Strathclyde, we tend to take a more

speculative approach than would be found in the wider industry. We would explore a new class of compounds or a new biological mechanism of action that has not yet been proved to be effective. But that's all part of fulfilling the research mission of universities, namely creating new opportunities that will make a difference to people.

What's clear is that success depends upon getting our chemistry right: a compound with the right size and shape to hit the target and with suitable properties to reach the target for long enough to be effective is required. Nobel Laureate, the Lord Todd, who was the first Chancellor of the University of Strathclyde, at a conference that I organised memorably put it this way: "Chemistry is the Queen of Science. Get your chemistry right and everything else follows!"



**Prof Colin J Suckling OBE DSc FRSE**  
**Research Professor of Chemistry**  
 Department of Pure & Applied Chemistry  
 University of Strathclyde  
 Tel: +44 (0)141 548 2271  
[c.j.suckling@strath.ac.uk](mailto:c.j.suckling@strath.ac.uk)  
[www.strath.ac.uk/chemistry/](http://www.strath.ac.uk/chemistry/)  
[www.twitter.com/unistrathclyde](https://www.twitter.com/unistrathclyde)



# Understanding the characterisation of sustainable materials

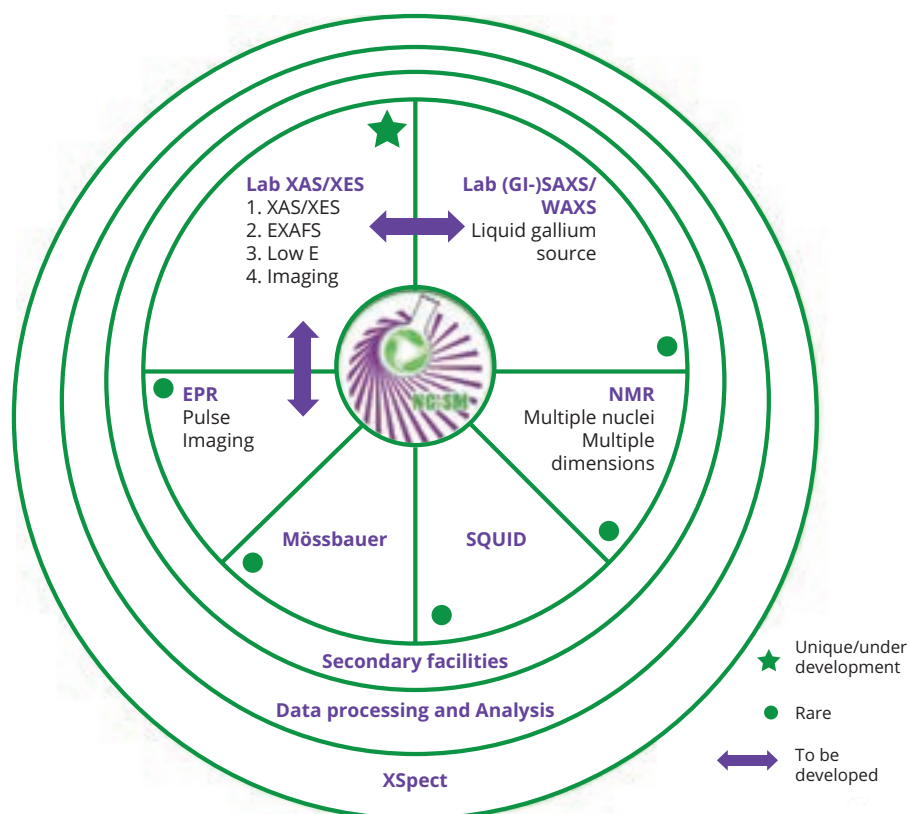
Moniek Tromp, Van t Hoff Institute for Molecular Sciences, Sustainable Materials  
Characterisation sheds light on sustainable materials and their benefits

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.

## 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



*Overview of the facility, including embedding with full laboratory and computational facilities as well as data processing and analysis. Moreover, a commercial service for data acquisition and analysis will be set-up (XSpect)*

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 scarce 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.

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**"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."**

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## 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.



UNIVERSITY  
OF AMSTERDAM

### Prof. Dr. Moniek Tromp Professor

University of Amsterdam  
Van t Hoff Institute for Molecular Sciences,  
Sustainable Materials Characterisation  
Tel: +31 20 525 6994  
[m.tromp@uva.nl](mailto:m.tromp@uva.nl)  
[www.suschem.uva.nl](http://www.suschem.uva.nl)  
[www.twitter.com/moniek\\_tromp](https://twitter.com/moniek_tromp)

# Novel approaches and challenges in the extrapolation of chemical effects across biological levels

Dr. Roel Evens, scientific project manager from SETAC Europe explores novel approaches and challenges concerning the extrapolation of chemical effects across biological levels

One of the biggest challenges in the ecological risk assessment of chemicals like pesticides, pharmaceuticals, industrial chemicals, personal and home care products and biocides is to extrapolate the effects of chemicals across different levels of biological organisation. Very traditionally, we measure for example the survival of a crustacean species in the laboratory, but we want to protect aquatic invertebrate populations in real ecosystems.

In most cases, this kind of extrapolation and the uncertainties associated to it are assumed to be covered using so-called assessment factors (AF), applied to the results of single species toxicity tests in the lab. Basically, the safe concentration of a chemical in laboratory conditions is divided by this AF to establish a safe concentration of the chemical in the field.

Nevertheless, there is still much of uncertainty on whether this extrapolation is protective enough or even overprotective. In higher tier risk assessments of some chemicals like pesticides and biocides, experimental approaches are available to address the higher and more complex levels of biological organisation, such as population studies in the lab, in the field and even at the community level (for instance, mesocosm studies). However, extrapolation itself is always a model-driven exercise and many uncertainties are associated with it.

Hence, although a lot of progress has been made with respect to modelling approaches, the actual incorporation into regulatory risk assessment has been limited so far. Historically, only a few experimental methods covering different levels of biological organisation are available and, due to their higher complexity, their use in risk assessment is often a matter of debate.

Such experimental approaches include i) sub-individual, in vitro and (cell-based) assays or biomarkers, ii) standard toxicity tests which can assess the effects at the population level for microorganisms but at the individual level for larger organisms and iii) micro & mesocosm experiments and field studies which are able to assess the effects at the population, community and ecosystem level. Until now, mechanistic ecological models to extrapolate from lower to higher levels of biological organisation are only sporadically accepted in regulatory risk assessment and mostly only to assess (dietary) exposure in the risk assessment for birds and mammals.

New developments which facilitate the extrapolation of effects observed in experiments amongst different levels of biological organisation include the quantitative adverse outcome pathways (AOPs), toxicokinetic-toxicodynamic modelling (link exposure to the individual level), population models (link individual to population level), ecosystem/food chain models (link population to community/ecosystem level) and landscape level models (which explicitly take into account the spatial heterogeneity of populations and ecosystems). These models can all be linked with each other to extrapolate the effects of chemicals from the sub-organism level to the ecosystem level, as well as to use experimental data to parameterise the extrapolations and to validate them.

One of the biggest advantages of such approaches is that they can not only extrapolate, but also integrate. For example, lethal and sub-lethal effects of chemicals at population levels can be interactively analysed and by linking such models to landscape scaled models, the effects of multiple stressors can be evaluated under



(semi-) realistic environmental conditions (for instance the effect of temperature increase resulting from climate change in combination with exposure to a chemical compound). These analyses can help overcome some of the biggest concerns when using ecological modelling and to ensure that all available testing information can be integrated with environmentally realistic risk assessment, for instance, to address the expected impact of chemicals on ecosystem services.

The Society of Environmental Toxicology and Chemistry (SETAC Europe) is organising a Special Science Symposium to present the state of the art in applying mechanistic ecological models in the risk assessment of chemicals in the environment. The symposium will kick off with the views and challenges of the relevant European institutions, such as the European Food Safety Authority (EFSA), the European Commission and the European Chemicals Agency (ECHA). This will be followed by a series of presentations by key experts on novel experimental and modelling approaches, as well as successful case studies on how these approaches

can inform future environmental risk assessments of chemicals in a regulatory context.

This symposium is a must for everyone involved in environmental risk assessment and who wants to learn more about the needs and challenges to adapt the latest mechanistic ecological modelling approaches to the different regulatory risk assessment schemes. ■

More info at <https://sesss13.setac.org/>

### **Dr. Roel Evens**

#### **Scientific project manager**

Society of Environmental Toxicology and Chemistry (SETAC Europe)

Tel: +32 2 772 72 81

[roel.evens@setac.org](mailto:roel.evens@setac.org)

[www.setac.org](http://www.setac.org)

[www.twitter.com/SETAC\\_world](https://twitter.com/SETAC_world)



# An emerging environmental health concern: Impacts of air pollution on the brain

Anthony S. Wexler and Pamela J. Lein from the University of California share their expert views on the impacts of air pollution on the brain

**A**ir pollution is a complex mixture of gases and particles in the atmosphere. Air pollutants are defined as compounds known to be deleterious to human health and welfare. In the United States, air pollutants are categorised as criteria and hazardous pollutants. The criteria pollutants generally derive from combustion processes in motor vehicles, electric generating stations and industrial processes.

Criteria gases include carbon monoxide (CO), sulphur dioxide (SO<sub>2</sub>), nitrogen dioxide (NO<sub>2</sub>) and ozone (O<sub>3</sub>); criteria particles are denoted by their size range, with PM<sub>10</sub> and PM<sub>2.5</sub> denoting the mass concentration of particles smaller than 10 micrometres (millionths of a metre) or 2.5 micrometres, respectively. Hazardous air pollutants are toxic chemicals, for example, benzene and arsenic.

In a comprehensive review of the worldwide disease burden of pollution, recently published by The Lancet ("The Lancet Commission on Pollution and Health", published online October 19, 2017, [www.thelancet.com](http://www.thelancet.com)), air pollution was identified as the predominant cause of pollution-associated morbidity and mortality. While the link between air pollution and respiratory and cardiovascular disease is well-established, more recent studies have raised concerns about the potential impact of air pollution on

the brain, particularly the developing and the aging brain.

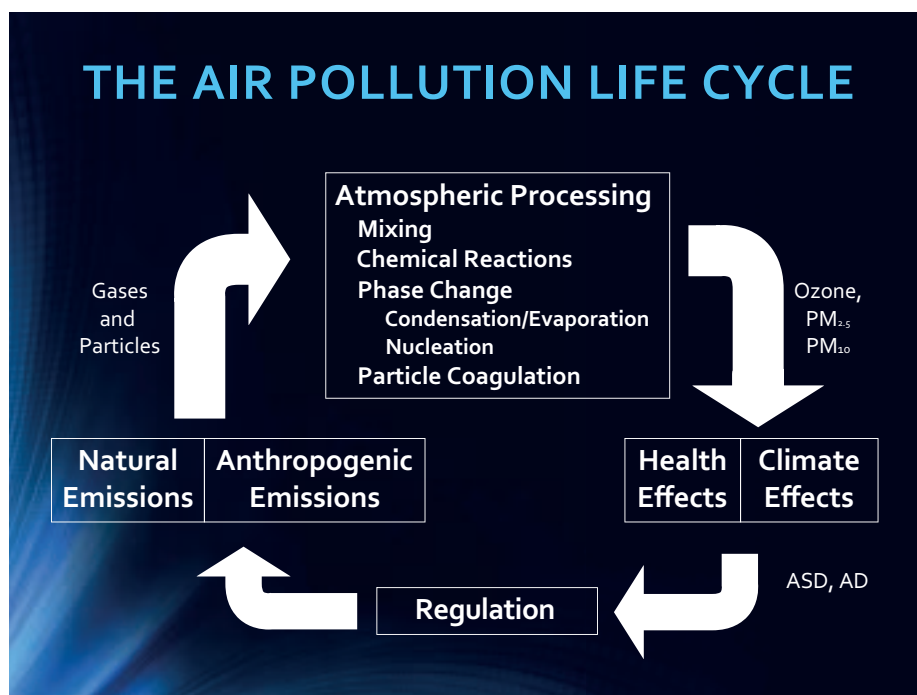
Air pollution and especially traffic-related air pollution have been associated with increased risk of neurodegenerative disease, in particular, Alzheimer's disease (AD) and diverse neurodevelopmental disorders, including autism spectrum disorder (ASD), attention deficit hyperactivity disorder (ADHD), learning and intellectual disabilities and schizophrenia. These conditions exact a tremendous cost on the affected individual, their families and society motivating support for research that determines whether these associations are causal and if so, what components in air pollution are responsible and what individual factors (gender, age, nutritional status, genetic makeup, etc.) determine whether exposure to air pollution will result in neurological disease?

Researchers employ two complementary disciplines – epidemiology and toxicology – to study possible links between air pollution and health. Epidemiologic studies use statistics to test the strength of correlations between increased exposure to a given pollutant and higher incidence of disease. Epidemiologic studies can identify associations in the human population; however, they have a key weakness, often summarised as "correlation does not establish causation".

Let us take for example living near heavily trafficked roadways, which has been associated with an increased incidence of ASD and AD. Is the effect due to the higher concentration of air pollutants near the roadway or due to the higher level of noise and vibration, or because housing is less expensive near busy roadways so people with lower incomes and possibly poor diet live near these roadways? And even if air pollution is the cause, which pollutant(s) cause the effect?

Another challenge arises from the fact that many neurological diseases, including AD and ASD, result from complex interactions between environmental factors and genetic susceptibilities: The wider the range of genetic susceptibilities within a population, the more challenging it is for epidemiology to identify clear associations between exposure and disease state.

Toxicology is a tool for unravelling these complex questions. To assess the health impact of air pollution, toxicologists use models ranging from cell cultures to laboratory animals and these can be engineered to express known human genetic susceptibilities to disease. In contrast to epidemiology, in toxicology, exposures can be controlled, and extraneous factors can be eliminated as variables, such as noise or diet in the near-roadway example above. In this way, toxicology



linking air pollution exposure to neuropathology? What components of the air pollution are causing neurological disease – Gases? Particles? Which ones? And what are the sources of neurotoxic air pollution? This last question is critically important because it is the sources that can be controlled by regulation. Answers to these questions, which will require toxicology in addition to epidemiology, are required to identify air pollution emissions control measures that effectively minimise neuropathological risks.



gists can determine if air pollutants cause an adverse health effect.

But toxicology faces the challenge of accurately mimicking human exposures. Think about the complexities of near-roadway air pollution, which is composed of incomplete combustion exhaust, brake wear, tire wear and road wear as well as derived from a mix of vehicles ranging from motorcycles to heavy duty trucks. At the University of California, Davis, we are addressing this challenge by locating animal exposure facilities adjacent to heavy traffic, so that the animals breathe the same mixture as people who live near busy roadways. In addition to assessing neurological outcomes in these animals, we are characterising the chemical composition of the air so future studies can assess the health effect of individual components within the polluted air to identify the disease-causing pollutant(s).

Why are we focusing on the near

roadway example? While regulations promulgated to reduce emissions have significantly improved air quality in cities across North America and Western Europe, improved air quality in geographic locations close to sources of air pollution, such as roadways, power plants and industrial facilities, have lagged behind. People living in these locations have a higher incidence of disease, including neurological disease. Since individuals in lower socioeconomic strata are more likely to reside in more highly polluted neighbourhoods, the problem of near-source air pollution exposure is not just a public health issue, but also an environmental justice issue.

In conclusion, epidemiologic studies have identified a number of neurological diseases associated with air pollution. But questions still remain: Is the association causal or is there another intervening factor that underlies the observed association? What are the cellular and molecular mechanisms

**Pamela J Lein**  
**Professor and Vice-Chair**  
 Department of Molecular Biosciences  
**Director, UC Davis CounterACT Center of Excellence**

**Anthony S Wexler**  
**Distinguished Professor**  
 Department of Mechanical and Aerospace Engineering  
 Department of Civil and Environmental Engineering  
 Department of Land, Air and Water Resources  
**Director, Air Quality Research Center**

University of California  
 Davis, CA 95616 USA  
 Tel: +1 530 752 1970  
[pjlein@ucdavis.edu](mailto:pjlein@ucdavis.edu)  
<http://www.vetmed.ucdavis.edu/faculty/results.cfm?fid=19369>  
<http://www.vetmed.ucdavis.edu/lein-lab/index.cfm>

# The challenge of replacing hazardous substances

Alberto Mantovani and Francesca Baldi from the Endocrine Disruptors Project-Istituto Superiore di Sanita shed light on the challenge of substituting hazardous chemicals

**W**hat happens when a substance is suspected or found guilty of adverse effect on human health or the environment? Removing a toxic chemical from a product's ingredients is only the first step through the bumpy road that leads to product safety improvement. When a toxic chemical is being replaced, some other substance will take its place to carry out that chemical's industrial performance. Substitution is meant to mitigate the health concern, however, in some cases a chemical or ingredient believed to be less hazardous may later be proved unsuitable because of toxicity, bioaccumulation, or other concerns, leading to what is called a "regrettable substitution". Let's look at two major food-related substitution issues

## The palm oil affair

The massive entry of palm oil into our food production occurred following the restrictions of the World Health Organization regulations on hydrogenated fats, such as kinds of margarines. <http://www.who.int/bulletin/volumes/91/4/12-111468/en/>.

In 2016, the European Food Safety Authority (EFSA) issued an opinion about the health consequences of food process contaminants of edible oils. EFSA specifically identified 3-MCPD (3-monochloropropane-1,2 diol), as a chronic toxicant for kidney and testes, whereas glycidyl esters were identified as genotoxic carcinogens.

Notwithstanding many uncertainties, the EFSA risk assessment identified potential health concerns for consumers, especially for younger age groups. Moreover, foods containing palm oil featured as main contributors to the overall intake, because it was liable to the formation of such contaminants and its widespread use. In the meanwhile, the levels of toxic by-products in foods is clearly dependent on technological processing, such as temperature (<https://www.efsa.europa.eu/it/efsajournal/pub/4426>).

Food industries are aware that their success depends on consumers' trust, in that the oils they use were safe. While they might have been taken aback by the EFSA opinion, the main food industries were probably aware of the issue of toxic by-products and willing to take a pragmatic approach, by reducing the levels found in refined vegetable oils, including palm oil.

Action became imperative as palm oil concern grew up to be an expensive, industry-wide concern. Attitudes could range from attempting to ignore the problem, in the hope that legislators would react slowly but risking the reaction by the consumers, to proactive intervention on the processing methods for vegetable oils. Another alternative is looking for a substitute.

Commercially available alternatives to palm oil are fats like coconut oil or

cocoa butter, which have a perceived health advantage over palm oil; indeed, available data show generally lower levels of 3-MCPD and glycidyl esters, but from the nutritional viewpoint there may not be a gain. Compared to palm oil, these fats have a similar level of saturated fatty acids whose high intake is a risk factor for cardiovascular diseases, a major cause of morbidity and mortality in Europe.

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**"From the industrial standpoint, searching for a universal substitute for a chemical such as BPA might not be the best strategy. Rather, it could be more effective to select a range of potential substitutes for different uses."**

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Also, alternatives must not be economically disadvantageous: compared to other alternatives, palm oil seems to afford higher production at lower costs. True, besides the health issue, palm oil intensive farming poses important issues of sustainability.

Beyond the scientific debate, palm oil has been boycotted also for environmental and ethical reasons, because of the impact of monoculture on local populations, such as expropriation and exploitation of peasant farmers and villages. But it must be ascertained in an objective manner that such issues do not exist for intensive, large-scale cultivations to produce coconut or cocoa oils, or other industrial cultivations, such as tobacco as

well. Thus, it is a struggle for a just cause, which may be somewhat naïve, as if compliance with laws and non-exploitation policies depend on the product itself, rather than on the interests behind it.

Coming back to exposure to process contaminants the most practical alternative may be palm oil produced with improved techniques that lower the levels of 3 MCPD and glycidyl esters. Admittedly, palm oil refined in such a way will incur additional costs, but these can be more than compensated by the increased consumers' confidence. The promotion of products (e.g., cookies) that contain fewer fats and the enforcement of state-of-art maximum limits for process contaminants of vegetable oils should go together with technological improvements to afford consumer safety.

## The BPA case

Bisphenol A (BPA) is a plasticizer known to be an endocrine disruptor also at low doses; concerns about its safety have led to its replacement with substitutes now found in a multitude of consumer products.

The ready-at-hand and cost-effective alternatives to BPA appeared to be other bisphenols that did not present endocrine disrupting properties, in particular, Bisphenol S (BPS). However, further studies have shown that BPS and other BPA analogs (BPF and BPAF) have estrogen-mimicking properties: while estrogen agonism was mostly investigated in vitro or in non-mammalian systems (e.g., zebrafish embryo) the nature and potency of effects were comparable to BPA.

BPS was also shown to induce lipid accumulation and differentiation of primary human preadipocyte, which

entails a further remarkable similarity to BPA; indeed, BPA is suspected to alter the metabolic balance and increase obesity risk upon prenatal exposure. Indeed, consumers should be cautious about the assumption that 'BPA-free' means, per se, that a product is safe

There is no doubt that BPA is a chemical with multiple uses (polycarbonate plastics, epoxy resins, thermal papers, etc.); and there is no doubt that is highly desirable to replace a chemical with such hazardous properties as BPA. Replacement, however, should make things better.

The first and most obvious aspect is that substitute candidates could appear "safer", simply because they have been less studied. Safety of substitutes should be assessed on a robust comparative basis, as proposed, for example, by the European LIFE project, LIFE-EDESIA <http://www.iss.it/life/index.php?lang=2> the current, rapid development of in silico screens and in vitro batteries can provide a reliable data set.

Of course, it would be highly un-effective to focus only on, for example, endocrine disruption, because this is the key concern of the chemical to be replaced: indeed, it would be purposeless to replace an endocrine disruptor with a mutagen! In silico screens are highly valuable, for such properties as genotoxicity or bioaccumulation: indeed, the potential for endocrine disruption would be better screened by in vitro assays because it involves more complex and often multiple mechanisms.

From the industrial standpoint, searching for a universal substitute for a chemical such as BPA might not be the

best strategy. Rather, it could be more effective to select a range of potential substitutes for different uses. The industry should also be aware that for new substances to be used in consumer products such as food contact materials, a full testing package according to up-to-date regulatory requirements is needed in EU. Thus, a robust and comprehensive screening battery is all-important, in order not to waste time, resources and expectations in compounds that eventually show up as potentially hazardous.

The substitution principle is pivotal to implement the favorable impact on health and environment by the REACH, the EU regulation on chemicals. To be effective in the real world, the process needs transparency and consistency of aims and methods, as well as keeping pace with the developments of toxicological and risk assessment sciences.



**Alberto Mantovani**  
Alberto.mantovani@iss.it

**Francesca Baldi**  
francesca.baldi@iss.it  
Endocrine Disruptors Project  
Istituto Superiore di Sanità  
Roma, Italy



# Disruptive innovation: How distributed ledger technologies are about to change society

European Commissioner for Digital Single Market, Andrus Ansip shares his thoughts on how digitisation is changing both people and society, including disruptive technologies such as blockchain

It is often said how much digitisation is changing people and society and how much it affects every sector of the economy. Technology facilitates access to social and economic services.

People's awareness is growing – along with their demands and expectations.

With financial technology, for example, one-third of digitally active consumers worldwide use two or more Fintech services, according to Ernst and Young's Fintech Adoption Index. It is a good reason why, so many industry sectors are investing in new and emerging areas, such as distributed ledger technologies or blockchain.

**“Blockchain-inspired technologies are being widely discussed around the world and tested across multiple industry sectors – energy, logistics, automotive, health among others – where the potential is being increasingly understood. According to a recent PWC report, more than 77% of financial institutions are expected to adopt blockchain by 2020.”**

Disruptive technologies like blockchain can help to reduce costs while increasing efficiency and transparency. They have huge potential for making social and economic transactions more secure online by guarding against an attack and removing the need for any middleman.

Today, most people use a trusted intermediary like as a bank to make a transaction. By contrast, blockchain allows groups of users, like consumers and suppliers, to link directly.

Image: © European Union, 2017



*Andrus Ansip, Vice-President, European Commissioner for Digital Single Market*

It can be used to record transactions carried out across many computers so that the record cannot be altered retroactively without the alteration of all subsequent blocks and the collusion of the network.

This provides an inexpensive and easy way to verify and audit transactions, which then become traceable and transparent: both essential elements in the fight against fraud.

What I also find inspiring about blockchain technologies is that they can allow mathematics and algorithms to create trust between parties that interact only occasionally, or may not know each other at all. They can co-create and share the database – safely and securely.

In its White Paper on blockchain published last year, the World Economic Forum said that the technology was “pulling us into a new era of openness, decentralisation

and global inclusion". Unlike the internet alone, it said: "blockchains are distributed, not centralised; open, not hidden; inclusive, not exclusive; immutable, not alterable; and secure." It is early days, but blockchain is definitely moving out of the lab and going mainstream.

Many people know it as the technology that enables cryptocurrencies like Bitcoin and Ether on Ethereum. But blockchain's potential uses extend far beyond digital currencies.

Blockchain-inspired technologies are being widely discussed around the world and tested across multiple industry sectors – energy, logistics, automotive, health among others – where the potential is being increasingly understood. According to a recent PWC report, more than 77% of financial institutions are expected to adopt blockchain by 2020.

Europe should see it as a new opportunity to innovate in services, to create businesses and new models. While it is too early to make firm predictions, blockchain can be expected to enable new enterprises to form, while transforming others. It will certainly create new jobs.

We should be ready to take up all opportunities that these technologies can provide, to innovate across many sectors – both public and private – while keeping an eye firmly on proper governance, security, protection of users and transparency. Other countries are already moving ahead.

That is why the EU is funding development of distributed ledger technologies, via the Horizon 2020 research and innovation programme, as well as pilot projects funded by the European Parliament.

We are also funding projects for testing blockchain in handling medical data, in social applications, RegTech and in media applications. This should expand further in 2018 and beyond, as the technology matures with an accompanying rise in interest and demand.

For this to work, a coordinated European approach is essential, rather than a patchwork of national initiatives – and one that is also technically interoperable. Fragmentation among countries will only hold us back as we continue to build a functioning Digital Single Market.

We are launching the EU Blockchain Observatory and Forum to expand our expertise on blockchain development, map existing initiatives, to explore use cases and any barriers to them and to monitor trends and developments. It will also gather all parties involved to address the various implications of blockchain: technical aspects, legal and regulatory concerns, governance and interoperability issues.

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**"Disruptive technologies like blockchain can help to reduce costs while increasing efficiency and transparency. They have huge potential for making social and economic transactions more secure online by guarding against an attack and removing the need for any middleman."**

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We plan to build on Europe's substantial talent base and excellent start-ups to become a leading world region that will develop and invest in the rollout of blockchain.

First, however, we need to formulate a clear European vision and strategy so that the right environment and conditions are created for EU countries and industry – from large companies to start-ups – to work towards this goal.

Blockchain development is still at an early stage – and Europe is still in a strong position to lead in this area. It is a new opportunity to innovate in services, to create businesses and new models and to be competitive on the global stage. We should not hesitate to do so. ■

**Andrus Ansip**  
**Vice-President, European Commissioner**  
**for Digital Single Market**

European Commission

[cab-ansip-web@ec.europa.eu](mailto:cab-ansip-web@ec.europa.eu)

[https://ec.europa.eu/commission/commissioners/2014-2019/ansip\\_en](https://ec.europa.eu/commission/commissioners/2014-2019/ansip_en)

[www.twitter.com/Ansip\\_EU](https://twitter.com/Ansip_EU)

# Blockchain and AI research at the University of Nicosia

Prof. Spyros Makridakis and Prof. George Giaglis, Directors of IFF at University of Nicosia lift the lid on the institution's blockchain and artificial intelligence (AI) research, including the launch of The Institute For the Future (IFF)

2018 may prove to be a historic year: as a number of technological innovations are reaching maturity and are converging with each other, it is now possible to imagine a singularity that will irreversibly transform the world as we know it.

Blockchains and digital tokens traded on them are at the epicentre of this transformation. If one looks beyond short-term discussions around the recent valuation spikes (and inevitable subsequent fall) of some of these tokens, we can't miss the promise of the newfound ability to create trust among people, who do not even need to know each other, without intermediaries, with only the help of distributed networks and the clever combination of public key cryptography and game theory economics. Such innovation promises to create a wholly new type of Internet; one on which value exchange will be as democratised as information exchange is on the Internet we know today.

Such innovation will surely be transformational in its own right, changing forever the role, structure and functions of today's prevailing markets, economies and perhaps even nation states. Just imagine then the possibilities opened up in a world in which such trustless networks will be connecting, not only humans, but also intelligent machines and even autonomous organisations. Ongoing developments in the field of artificial

intelligence (AI) have enabled scientists to design algorithms that learn on their own, without the need for supervised human training. And they can learn so fast that, after a few 24 hours of self-training, are able to surpass human performance in fields like playing chess, beating poker champions, recognising faces in images, synthesising speech, even negotiating with humans (and with each other).

As such algorithms become powerful, cheap and widespread enough to replace humans across various jobs and functions, they will usher an era in which machines will engage in human-to-machine (H2M) and machine-to-machine (M2M) commerce. The impact to competitiveness, productivity and growth will be so immense that people will soon find themselves unable or unwilling to compete with their algorithmic partners, delegating more and more economic activity to machines and being freed up to engage in other, mostly unthought-of and unsearched activities.

Drawing on such convictions, the [University of Nicosia](#) (UNIC), has been among the first universities in the world to embrace the technologies of the future and bring them together into a new interdisciplinary research centre devoted to advancing their technological, business, social, regulatory and ethical implications.

The Institute For the Future (IFF) aims at expanding our understanding of blockchain and AI as well as their effective integration, contributing to their effective application in industry, government, education and society in general. IFF's vision is to become a leading academic institution and a top global player spearheading interdisciplinary research and innovation inside the university, in Cyprus, in the EU and the world.

IFF is headed by [Professor Spyros Makridakis](#) and [Professor George M. Giaglis](#) and its blockchain activities by [Professor Soula Louca](#). IFF is staffed by a growing number of professors, post-doc researchers, doctoral candidates, graduate students and admin staff, also offering visiting positions to prominent scholars from industry and academia.

IFF also sponsors, either from UNIC funds or from industry backers, Ph.D. students and IFF post-doctoral researchers to work in the above areas with it's in residence scholars, senior associates and visitors. Finally, IFF is also working toward establishing an incubator/accelerator for promoting promising technology entrepreneurs and dynamic start-ups in its areas of expertise.

IFF has already made significant progress in the field of blockchain and AI. UNIC is today considered the leading university globally in the digital



*UNIC CEO, Antonis Polemitis, Interviewing Member of European Parliament, Eva Kaili, at Decentralized 2017*

currency and blockchain field. As the first university to offer a course on cryptocurrency, a free online course Introduction to Digital Currencies, taught by Andreas Antonopoulos and Antonis Polemitis, the MOOC has enrolled over 15,000 students from 80 countries since 2014.

Furthermore, UNIC's MSc in Digital Currency was the first academic degree programme in the world in this field, graduates of which have been involved in leading blockchain organisations worldwide. Over 350 students from around the world have enrolled in the programme, representing a wide range of backgrounds, including financial executives, blockchain entrepreneurs and software developers. Graduating students have gone on to work at key firms in the industry, created startups in the blockchain space or work in government and academia. Similarly, its AI publications have appeared in both academic and practitioners' journals.

Adding to its leading position, UNIC is the first university in the world to offer instant, electronic authentication of its certificates (Bachelor, Master and Doctoral Degrees), via an online verification tool on its website. Specif-

ically, all certificates issued as of Spring 2017 have been digitised using blockchain technology and are available to students online. Each certificate's fingerprint has been added to Bitcoin's blockchain, offering users (e.g. potential employers) immediate, secure and digital authentication.

UNIC's prominent role in academia has been recognised by blockchain industry publications in their evaluation of UNIC's position among universities in the field as it is confirmed by their rankings – CoinDesk (#1, 2016), the Merkle (#1, 2017). UNIC's blockchain initiatives have drawn immense interest from global media over the years, with over 300 articles written about UNIC's activities by global media organisations such as the Wall Street Journal, Associated Press, Euronews, Forbes, Time, Fast Company and many others (for more information about UNIC's digital currency and blockchain initiatives, see <https://digitalcurrency.unic.ac.cy>).

Today, UNIC, through its School of Business, School of Sciences, The Institute For the Future (IFF), has probably the largest team in the academic world working on cryptocurrency and blockchain issues, with over 35 faculty,

industry lecturers, administrative staff and guest lecturers involved with the initiative, across teaching, research and software development. In addition, it is developing its AI activities and, as mentioned, their integration with blockchain.

Recently UNIC organised DECENTRALIZED 2017, a major conference in Europe focusing on the business and political implications of blockchain technologies, across several key industries, including shipping/supply chain, financial services, government, accounting/auditing and legal and governance, along with predictions on the long-term implications of blockchain and artificial intelligence on our society and firms.

The event hosted over 500 participants from all over the world for a three-day summit, showcasing 50+ speakers from various sectors of the industry and academia. This year's conference, DECENTRALIZED 2018, to be held in November, will bring together more than 1,500 attendees and more than 70 speakers in a two-day world-class event (see more details and register at <https://www.decentralized.com>).



**Prof. Spyros Makridakis**  
**Director of IFF**

University of Nicosia  
Tel: +357 2284 1948  
[digitalcurrency@unic.ac.cy](mailto:digitalcurrency@unic.ac.cy)  
[digitalcurrency.unic.ac.cy](https://digitalcurrency.unic.ac.cy)  
<https://twitter.com/MScDigital>



# Leading Portugal's blockchain revolution

In a special interview with Open Access Government, Justin Wu from Etherify sheds light on the firm's role as a leader in Portugal's exciting blockchain revolution

**E**therify is the first Ethereum consulting and software development firm in Portugal. Etherify was started in April 2017 by two young entrepreneurs: Justin Wu and Fernando Moreira. Since then the firm has grown to become a leader in the blockchain revolution in Portugal. With projects ranging from commercial banking, the charity fundraising industry and video-games, Etherify's CEO Justin Wu sat down with Open Access Government (OAG) to discuss his experience.

## **OAG: Where did the idea of Etherify come from?**

**JW:** I've been involved in cryptocurrency in one way or another since 2013, during the first big Bitcoin bull-run. Although it was exciting to watch the price action, I was also very interested in the technology behind Bitcoin: the blockchain. When Ethereum came out in 2014 and had a programmable blockchain with its own programming language, I knew that I had found something special. It was like catching a glimpse of the future. Programmable money! Now that's an amazing idea. I knew I had to be a part of this, so I began studying it in my free time. Then in late 2016 I met my partner Fernando, who runs a start-up incubator in Lisbon, and Etherify took off from there.

## **OAG: Why did you choose Portugal, of all places, to start your business?**

**JW:** Portugal has an incredible entrepreneurial spirit and a heart for innovation. I came here several years ago at the bottom of the economic crisis in the country and I saw many people who were down on their luck. But then entrepreneurs took it upon themselves to create a renaissance in the city and redefine what it means to do business here in Portugal. I think Ethereum is a sort of force multiplier for start-ups, because it allows them to compete with larger incumbents in ways that they couldn't before.

A great example is funding. Nowadays, a start-up can do an Initial Coin Offering (ICO) and get funding for their idea or to bring their prototype to finished product and then to market. Before these start-ups would have to go to VCs and the process was much harder and you'd have to give up equity. Etherify wants to help other Portuguese start-ups get funding through ICOs and/or use Ethereum to help them both compete and innovate.

From a regulatory standpoint, the Portuguese government has started initiatives to help both start-ups and fintech firms. We at Etherify are pushing to get blockchain recognised as a

huge untapped business opportunity for the country on the national level. We are a member of Associação Fintech e Insuretech Portugal (AFIP) and we helped to organise the Blockspot Conference, the first international blockchain conference based in Lisbon, Portugal.

## **OAG: Why did you choose Ethereum as your focus, why not other blockchain platforms?**

**JW:** For us, Ethereum is the most flexible blockchain to use. From a development standpoint, Ethereum has the most developers and developer tools out there of any blockchain ecosystem currently available, so it is the best for a firm such as us. Ethereum has the most network effects as well, indeed it handles more transactions per day than all other blockchains combined, including Bitcoin. At the enterprise level you have many Fortune 500 companies joining the Enterprise Ethereum Alliance, so I think we are in good company.

## **OAG: Why not just use Bitcoin, for example?**

**JW:** Ethereum will very soon become the #1 cryptocurrency in terms of market cap. It already is #1 in developers and developer mind-share. This



*Fernando Moreira and Justin Wu*

is important because everyone nowadays is talking about Bitcoin. But it is just a matter of time before Ethereum overtakes it in price and this is important to have as the leader in the cryptocurrency space, a platform that actually cares about things like scaling, decentralisation and privacy.

Bitcoin is like a pocket calculator. It is only good for one thing: moving value from one person to another. Ethereum is like a brand-new smartphone. Developers can create any type of application for Ethereum for any use case. The programming language for Ethereum called Solidity is much more flexible, useful and easier to learn than Bitcoin's programming language. There is much more developer support and documentation for Ethereum developers than for Bitcoin, in my opinion.

Scaling the network is a huge issue too. Currently, no blockchain technology can scale to the level where it is ready to handle the transaction demands of the entire human race. Only Ethereum has scaling solutions in development and ready to both test and deploy in the early part of 2018. Bitcoin currently has no viable scaling solution, and their leadership is questionable, at best.

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**“What we are witnessing is the birth of a new asset class that I believe will grow to dominate both the economy and finance over the coming years. I'll tell you what the real bubble is: The Federal Reserve and other central banks printing money out of thin air like there is no tomorrow.”**

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Ethereum's core developers are unified behind their leader Vitalik Buterin

on Ethereum's scaling vision. Currently, Ethereum can handle around 20 transactions per second. To get on the level of Visa/Mastercard, Ethereum would have to increase this to at least 4,000-5,000 transactions per second.

Network upgrades to Ethereum such as Proof of Stake, Raiden and Sharding would allow Ethereum to surpass these transaction capacities. These upgrades are all slated to come out during 2018.

**OAG: Can you tell us about some of the projects you are working on?**

**JW:** We have two ICOs in the pipeline right now: Gamestatix and Hustle for Humanity.

Gamestatix is going to do the video-

games industry what AirBnB did to hotels. The video-games industry has two fundamental problems: discoverability and lack of robust incentives for co-creation of video-games.

The discoverability issue is the major problem. Big game studios dominate the charts time and time again because they just release further iterations of the same game franchise. Thus, you have Battlefield 4, Final Fantasy 17, etc. etc. Newer game studios and franchises can't break into the public consciousness because these incumbents have millions of dollars to market and stay on the top.

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**"Bitcoin is like a pocket calculator. It is only good for one thing: moving value from one person to another. Ethereum is like a brand-new smartphone. Developers can create any type of application for Ethereum for any use case."**

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Gamestatix is creating a token that will be rewarded to gamers for playtesting new video games, from early-stage development and for being an active member of that game's community. Gamers are also rewarded for both creating and curating content. So, we are tackling the two big problems in the video-game industry, with our token and platform.

Hustle for Humanity is a fantastic project in that it aims to disrupt the for-profit charity fundraising business. And it is a business. Did you know that many charity fundraising firms routinely keep up to 80% of the funds raised through them, only leaving 20%

to go to the charity? Some fundraising firms even lose money. We think that is very unfair and we want to cut out the middleman in charity fundraising using blockchain technology and a unique incentive structure.

**OAG: Sounds interesting. But many people are asking, 'are cryptocurrencies in a bubble'?**

**JW:** Absolutely not. What we are witnessing is the birth of a new asset class that I believe will grow to dominate both the economy and finance over the coming years. I'll tell you what the real bubble is: The Federal Reserve and other central banks printing money out of thin air like there is no tomorrow. These people are imposing a hidden tax on the public, which is to erode their spending power over time. People are buying into Ether and other cryptocurrencies, because they want to preserve their purchasing power and even see it grow. The supply of cryptocurrencies cannot be artificially inflated by some bureaucrat. The rules are set by code, decentralised consensus and mathematics.

The key to first-time investors is to choose the right projects to invest in and avoid the others like the plague. Ethereum (ETH) is the best bet, in my view. Of course, I am biased, but if you do your research you can see that of the Top 100 coins on Coin Market Cap, 88 of them are based on Ethereum, or are Ethereum itself. The Enterprise Ethereum Alliance is the biggest blockchain consortium in the world

and counts among its members Microsoft, JP Morgan, Reuters and the CME, to name a few.

Lastly and this is important, beware of scams and keep yourself safe. Always use a hardware wallet like a Ledger Nano S and buy from their official website. What I'm saying is not investment advice and you have to do your own research and due diligence. Please be careful out there.

**OAG: What's in it for the future of Etherify?**

**JW:** The future is bright for Etherify. We are planning on launching our ICO projects and expanding to hire more people and to be a part of the emerging start-up and blockchain scene in Portugal. Please check out our website at <http://www.etherify.io/> to discover more.



**Justin Wu**

Etherify

Tel: +351 967 461 477

[justin@etherify.io](mailto:justin@etherify.io)

[www.etherify.io](http://www.etherify.io)

[www.twitter.com/etherify\\_io#](https://twitter.com/etherify_io#)





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# Mont-Blanc project: preparing for next-generation supercomputing

Etienne Walter, Mont-Blanc 3 coordinator at Atos shares an expert perspective on how the Mont-Blanc project is preparing for next-generation supercomputing

Arm low-power processors dominate the mobile world of smartphones, tablets and embedded IoT devices. With data centres consuming ever more power, the idea of using highly energy-efficient Arm chips in servers is enticing, especially for energy-hungry high-performance computing (HPC) configurations. As early as 2011, several pioneering European companies and institutions recognised the tremendous potential offered by embedded processor technology and decided to unite into the Mont-Blanc project to investigate the usage of low-power Arm processors for HPC.

**“Interest for Arm processors is rising rapidly in the HPC community...”**

However, making the leap from the mobile market to HPC was not trivial: HPC-optimised libraries, compilers and applications did not exist for Arm platforms. Mont-Blanc partners had to start from scratch building Arm HPC test systems based on 32-bit mobile phone technology and porting and tuning software and tools to create an Arm software ecosystem. In 2015, Mont-Blanc deployed the world's first Arm-based HPC cluster, featuring over 2,000 mobile CPUs. This system helped demonstrate the viability of using Arm technology for HPC.

Six years on, the landscape has changed dramatically. Arm has introduced its first 64-bit architecture –



*Mont-Blanc team receives HPCwire award at SC17*

ArmV8. The Mont-Blanc team put a lot of effort into extending and consolidating the ecosystem developed under the first phase of the project: scientific libraries and runtime systems were ported to ArmV8 and a set of development tools was developed for debugging, performance analysis, performance prediction and automated kernel optimisation.

Interest for Arm processors is rising rapidly in the HPC community, as demonstrated for example by the amount of attention given to all Arm events and announcements at the SC conference in November 2017, or by the HPCwire award received by Mont-Blanc for “Best HPC Collaboration (Academia/Government/Industry)”.

Besides purely technological considerations, Arm processors are increasingly viewed as a major asset for Europe's self-determination in HPC, not only by the European Commission, but also by many leading HPC organisations in Europe.

In this favourable context that it contributed to create, the Mont-Blanc project, now in its third phase, is moving ahead. It leverages the findings of the previous project phases to imagine a new high-end HPC platform that will be able to deliver a high-performance/energy ratio whilst executing real applications.

More precisely, the first technical objective of the project is to create a well-bal-



anced architecture and deliver the design for an Arm-based SoC or SoP (System on Package) capable of providing pre-exascale performance – and measured using real HPC applications.

The second objective is to maximise the benefit of this new architecture for HPC applications with new high-performance Arm processors and throughput- oriented compute accelerators designed to work together.

**“One of the first outcomes of the Mont-Blanc 3 project is a new prototype based on 64-bit ThunderX2 processors from Cavium®, relying on the Arm® v8 instruction set.”**

Finally, the third objective is to develop the necessary software ecosystem for the future SoC – a fundamental asset to maximise the project impact and ensure real life success for this Arm architecture.

For example, one of the issues we are investigating is the need to transform applications from being latency limited to being throughput limited. This was an essential finding of the previous phases of Mont-Blanc. In the same way, kids throw a tantrum to obtain immediately something they desper-

ately need, our programmes issue a request for a resource and stall until whatever they require is available.

Various costly techniques are implemented to achieve some overlap between computation and communication, but our belief is that much more aggressive levels of look-ahead in work/resource demand generation and less urgent synchronisation demands can be achieved by resorting to an asynchronous task-based programming model such as OpenMP4.0 or OmpSs. This transformation from latency-limited (by the response time of individual resource requests) to throughput-limited (by the total amount of resources available) is a key enabler for the future, not only in HPC but also for general purpose computing.

One of the first outcomes of the Mont-Blanc 3 project is a new prototype based on 64-bit ThunderX2 processors from Cavium®, relying on the Arm® v8 instruction set. The system is now live at the Atos R&D centre in Les Clayes near Paris and leverages Atos’ Bull Sequana infrastructure, such as cluster management, network, power supply and cooling. It was christened Dibona, after the Dibona peak in the

French Alps and the full configuration will ultimately include 48 computes nodes, i.e. 96 Cavium® ThunderX2 CPUs, or 3000 cores.

Dibona is not the end-product of the Mont-Blanc project, but it is a key tool that will allow project partners to expand their research, validate Mont-Blanc performance models and test the completeness and usability of Mont-Blanc’s solution. The exciting news about this prototype is that it will not remain a prototype: Atos has decided to productise it and commercialise it as a standard Bull product under the name Bull Sequana X1310.

The Mont-Blanc 3 project is not over yet, but we already know that its outcomes will be put to good use: the Mont-Blanc 2020 project, a spin-off of Mont-Blanc, has just started, with the ambition to pave the way to a European scalable, modular and power efficient high-performance computing.

The Mont-Blanc 3 cooperative R&D project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 671697. The project partners are Bull (Atos group, coordinator), ARM, AVL, BSC, CNRS, ETH Zürich, HLRS, Universität Graz, Universidad de Cantabria, UVSQ.



**Etienne Walter**  
**Mont-Blanc 3 coordinator**  
 Atos  
[etienne.walter@atos.net](mailto:etienne.walter@atos.net)  
<http://montblanc-project.eu/>  
[www.twitter.com/MontBlanc\\_Eu](https://twitter.com/MontBlanc_Eu)

# Blockchain in business: Telegram app said to launch its own crypto payment network

In this article, the founder and co-founder of the Blockchain Federation provide insight into the use of blockchain in business, including how the Telegram app is said to launch its own crypto payment network

Ever since the smartphone, we all know Telegram as a worthy and very secure alternative to WhatsApp, hence the 200 million active users of the popular app. What's more, over the past years Telegram has matured into a multi-application platform allowing for games, exchange of photos/videos/stickers, audio and other files, secret chats and more. The most recent strategic move Telegram's is said to make is the launch of its own cryptocurrency: Gram.

Gram is supposed to allow users to perform (international) payments quickly and securely. The crypto is to be integrated with the encrypted platform. Based on preceding successes of other cryptocurrencies, the network is referred to as a third-generation blockchain application. This entirely new blockchain is to be called TON (Telegram Open Network). According to unconfirmed information, the TON network is a lightning-fast, multi-blockchain architecture automatically splitting in two before the blockchain(s) become too large there-with increasing capacity, referred to as 'scalable infinite sharding'.

All TON blockchains can quickly share data using a smart routing system. It uses direct payment channels to transfer value in milliseconds, smart contracts included, based on Proof-of-Stake (PoS). Each block in a TON blockchain can become a blockchain of its own, making the structure immensely flexible. If TON can indeed securely handle 'millions of transactions per second', every financial institution on the face of this earth is in dire straits – VISA and Mastercard in particular. This could well be a reason why the owners have stated not to sell Telegram, not even for \$20 billion. TON is also said to easily accommodate billions of users and thousands of applications. When thinking of other applications such as in hedge funds, FX trading



*Eddy Wagenaar and Irina S. Zimakova*

and similar financial uses to name a few, the sky and future net worth of Telegram are limitless.

Telegram was launched in 2013 by Russian brothers Nikolai (an award-winning mathematician and programmer) and Pavel Durov, who had previously founded the Russian social network VK (basically a Russian Facebook equivalent – very popular), however left VKontakte following acquisition by the Mail.ru Group, one of Russia's largest internet companies oper-



ating e-mail service and Russia's other most popular social networking site Odnoklassniki.

Telegram's end-to-end and server-to-client encryption is regarded to be extremely safe and reliable, sadly making the app very popular with terrorists as well. Registered as both an English LLP and an American LLC, Telegram does not disclose where it rents offices or which legal entities it uses to rent them, citing the need to "shelter the team from unnecessary influence" (FBI) and protect users from governmental data requests. It's that safe. Durov is said to be moving from country to country with a small group of computer programmers, currently based in Dubai. They left their home country Russia with an estimated \$300 million from the VK sale and 2,000 Bitcoin.

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**"According to unconfirmed information, the TON network is a lightning-fast, multi-blockchain architecture automatically splitting in two before the blockchain(s) become too large therewith increasing capacity, referred to as 'scalable infinite sharding'."**

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As Telegram is a very well-known and established app and not exactly a start-up anymore, there is a profound interest within investors worldwide to go "all-in" in the alleged upcoming biggest ever ICO (the crypto/coin equivalent of an IPO – Initial Public Offering, the first time the stock of a private company is offered to the public). Apart from sky-rocketing pre-ICO investment figures, the upcoming ICO would be set to break records with an estimated rise of \$2 billion, expected to even exceed \$5 billion. While the public sale isn't scheduled to launch until March 2018, its whitepaper and investor prospectuses were leaked across the internet, unfortunately resulting in a scammer's dream.

At least four fake websites emerged making false claims to either have pre-ICO low-priced tokens in stock or otherwise. This is exactly why governmental regulatory bodies, such as the English FCA (Financial Conduct Authority) and its international counterparts regularly warn for -or sometimes even prohibit- invest-

ing in ICO's since they are not (yet) regulated by the state. Carefully verifying and fact-checking details from multiple sources before participating in a token sale, is an absolute must to prevent investing in a scam.

Telegram management, by the way, tweeted its official announcements are published only at telegram.org. We, the expert authors of this article, would question how Telegram intends to overcome or bypass the Byzantine Fault Tolerance problem. Also, a state free community with its own cryptocurrency almost sounds too good to be true at this particular stage of global blockchain developments. Mind you, many of today's blockchain solutions targeted at overcoming speed issues are hybrid blockchain solutions that run on a slapped-together-sandwich-combination consisting of vulnerable off-chain legacy systems (speed) and on-chain recording (immutability). Marketing still performs miracles in the world of the ignorant. ■



**Eddy Wagenaar**  
**Chairman, Digital Embassy**  
**founder, Blockchain Federation**

**Irina S. Zimakova**  
**President, Digital Embassy**  
**Co-founder, Blockchain Federation**

<https://blockchainfederation.org>

<https://digitalembassy.org>

<https://fintechfederation.org>

[www.twitter.com/EUBlockchainFed](https://www.twitter.com/EUBlockchainFed)



# Security and responsibility around decentralised personal data

Simon Kavanagh from Tieto explores the importance of both security and responsibility when it comes to decentralised personal data

**D**o you remember that café in Barcelona which served you a delicious cortado while you surfed their free WIFI? Do you remember the personal information you gave them when you signed up? Surely you read their terms and conditions? More importantly, do you know who has your information now and what they are doing with it?

If you are not working in the area of online privacy and security and are not a member of a group such as [Necessary and Proportionate](#) or routinely [paint your face](#) to confound facial recognition algorithms, then chances are you didn't know you were giving personal information away and you certainly don't know where it is now. It's also likely that you don't really care. The majority of people who regularly use online services don't know or care about the leakage of their personal information. The old adage states that if a service is free then you are the product ([think GAF](#)A), but it's also true that the most common response is: meh (expressing a lack of interest or enthusiasm).

What exactly is the problem with a café holding onto your email address, IP address, date of birth and name? What impact does this have on your life? Well, if you're lucky then none at all. But luck is hardly a long-term strategy for online security. As more and more of your personal data is being vacuumed up, stored in dubious loca-



tions and used without my informed consent, then you will soon run out of luck.

Identity theft is one of the most obvious risks. And it's a frighteningly trivial thing to accomplish. All that's needed is some basic personal information (name, address, phone number, social security number etc.) which can be used to trick a phone company (for example) into thinking you are your victim. When this is accomplished you can re-route SMS traffic (including one-time-passwords) and voilà. The attacker now has access to your bank account.

A [recent study](#) by a research group showed that in the US alone identity theft hit a record 15.4 million people in 2016, a rise of 16% on the previous year. And if you think it's only your public Facebook profile which is leaking sensitive data then take a deep breath and [have a look at this map](#) showing known medical data breaches in the US from 2009-2016. Closer to home, we have this [nice guideline](#) from the Finnish consumer authority, which urges you to take precautions to prevent the same thing happening to you.

Nefarious use of your personal data is one downside of the IT-saturated lives we live. But there are also fantastic possibilities for positive uses of your personal data. This is an area Tieto are especially interested in. For example, why does one identical twin develop a hereditary disease when their sibling does not, though they grew up together, shared the same experiences and have ([almost](#)) identical DNA? Unravelling this puzzle involves combining Genotype data with Phenotype data from disparate sources in coordinated research focused on uncovering the links between the two.

And here's the tricky thing: this data needs to move as per the owner's informed consent. A citizen-centred, consent network is essential here. This is the challenge that Tieto (together with California start-up Gem) [has undertaken](#). We see a future where anyone can see where their most valuable information is. From there they can take control and make informed decisions as to its use. We don't see technology as the major stumbling block here (although recent innovations in distributed ledger technology have made a consent network more secure). Raising awareness and



combating apathy is much more challenging. Most people simply don't care. To get over this, Tieto are focusing heavily on user-centred design. The challenge we've set ourselves is: how do we design for empowerment?

Outside of research, a citizen-centred consent network which is naturally cross-border is also useful if you ever want to invoke your EU right to have a medical procedure carried out in another member state. This EU right is related to the freedom of choice vision in the Finnish SOTE reform – but exposes the limits of that vision too. In Finland, to realise the Freedom of Choice vision your healthcare data needs to move fluidly between the different professionals. Kanta is the national platform backed by the Finnish government, which will certainly help the movement of your data between Finnish health providers (public and private). That's excellent, but it works right up to the edge of the Finnish national border and no further.

As of now, there is no easy way your health data moves electronically

between EU member countries – instead health tourists are forced to carry a USB drive, a DVD or a folder under their arm (see this report here commissioned by the government of Estonia for more information on the restrictions to the free movement of Health Data). A fundamentally different sort of network is needed for the age where EU medical tourism becomes the norm. One where citizens themselves control who does and doesn't have access to their medical data. There are many aspects of a successful network such as this. As explained earlier, citizen-centered consent is one. Two others are Identity Verification and Information Veracity (Tieto are also working on these two aspects of trusted transactions together with the Sovrin foundation).

Unfortunately, instances of identity theft and other forms of data-based attack show no signs of decreasing. But these negative consequences of living in the digital age should be balanced against the enormous possibilities we have to build more citizen-centred and empowered IT

solutions and services. Tieto is committed to this positive future and we want you to be in control.

Read more about our thoughts on blockchain here:

Self-sovereign identity delivers MyData in practice.

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# tieto

**Simon Kavanagh**  
**Head of innovation and design in**  
**healthcare, welfare and education**  
 Tieto  
 Tel: +47 912 43949  
[simon.kavanagh@tieto.com](mailto:simon.kavanagh@tieto.com)  
[www.tieto.com](http://www.tieto.com)  
[www.twitter.com/TietoCorp](https://www.twitter.com/TietoCorp)

# Switzerland, blockchain's spiritual home

The Crypto Valley Association's Tom Lyons argues that along with its competitive advantages, decentralised culture and democratic tradition have made Switzerland an epicentre of the blockchain revolution

Few places in the world are more idyllic than the Swiss city of Zug. Situated on a pristine alpine lake, snow-capped peaks in the distance, church towers hovering over cobblestone streets, it gives off an aura of stability and old-fashioned traditions. Yet these quaint airs can be deceiving. As an epicentre of blockchain, the revolutionary technology behind Bitcoin and other cryptocurrencies, Zug is cutting edge.

The Ethereum Foundation, which oversees the technology behind ether – the second-most popular cryptocurrency after Bitcoin – was established in a ground floor conference room 5 minutes' walk from the Zug train station. Zug is home to early innovators like the cryptocurrency exchange Bitcoin Suisse, which among other things runs Bitcoin ATMs in most Swiss cities and the Zug government itself, which caused a media stir when it became the first in the world to accept Bitcoin as payment for government services.

It was one of Ethereum's founders who, impressed by the blockchain scene he found in Zug 4 years ago, coined the term Crypto Valley. We now use that term to refer to the blockchain community in all of Switzerland and that community is burgeoning. Switzerland, for instance, has become one of the world's most favoured locations for blockchain fundraising through initial coin offerings (ICOs). It is also headquarters to many of the most important blockchain companies, with new start-ups seeming to arrive every day.

## The innovation magnet – what's the draw?

The world's most competitive country 6 years running according to the WEF, Switzerland has always been a good place for technology or other high value-add enterprises.

It has excellent infrastructure, some of the best academic

institutions in the world, a highly skilled and motivated workforce, as well as low corporate and individual taxes. It is also prized by businesses for its political stability, rule of law, strong, stable currency and deep pools of capital.

The Swiss regulator has been open and supportive of blockchain technology. To foster innovation, it introduced a Fintech "sandbox" that allows start-ups – including blockchain-based ones – to safely experiment with innovative products having to do with money. It has also taken a generally liberal approach to cryptocurrencies, ruling that not every token is a priori a security and must be regulated.

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**"The world's most competitive country 6 years running according to the WEF, Switzerland has always been a good place for technology or other high value-add enterprises. It has excellent infrastructure, some of the best academic institutions in the world, a highly skilled and motivated workforce, as well as low corporate and individual taxes. It is also prized by businesses for its political stability, rule of law, strong, stable currency and deep pools of capital."**

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Local governments have been supportive too. Along with accepting Bitcoin for government services, Zug recently implemented a blockchain-based digital ID system for residents. In the Swiss city of Chiasso, residents can pay local taxes in Bitcoin. You can buy Bitcoin at any of the Swiss national railways' more than 10,000 ticket machines.

All this has helped the Swiss blockchain ecosystem grow at a torrid pace. When we started the Crypto Valley Association (CVA) at the beginning of 2017 to help support the ecosystem here, we had 16 members. We ended the year with over 550.





### The spirit of the thing

While Switzerland has much to offer blockchain as a technology, it is not the whole story. What makes Switzerland special for me and many others in the community is also its affinity with blockchain as an idea.

One way to understand blockchain is as a shared database that allows complete strangers, even antagonists, to come to an agreement on information – and record that information in a way that makes it both unalterable and accessible to all. That has far-ranging consequences.

The real revolution behind what The Economist called blockchain's "trust machine" is not cryptocurrencies, but decentralisation. Look closely at almost any blockchain project and you will likely find an effort to replace some top-down, centralised model with a bottom-up, flat, decentralised one. Thanks to the trust that blockchains make possible, we no longer need a central authority to keep the records and make the ultimate decisions. Now the community can do that on its own.

That makes blockchain profoundly democratic – which in turn makes it profoundly Swiss. With its federalised political structure, under which a great deal of decision-making is devolved to the local communities, and its system of direct democracy, in which citizens

vote on almost everything, Switzerland may be the most decentralised healthy country in the world. With its deep respect for personal privacy and strong data protection laws, it is also one of the most respectful of individual rights.

These things appeal deeply to the idealists of blockchain, of which there are many. So, while Switzerland has much to offer blockchain on a practical level, you can argue that it's the spirit of the place that has made it such fertile ground for this revolution – and should continue to do so for a long time to come. ■



**Tom Lyons**  
**Chair, Communications Working Group**

Crypto Valley Association

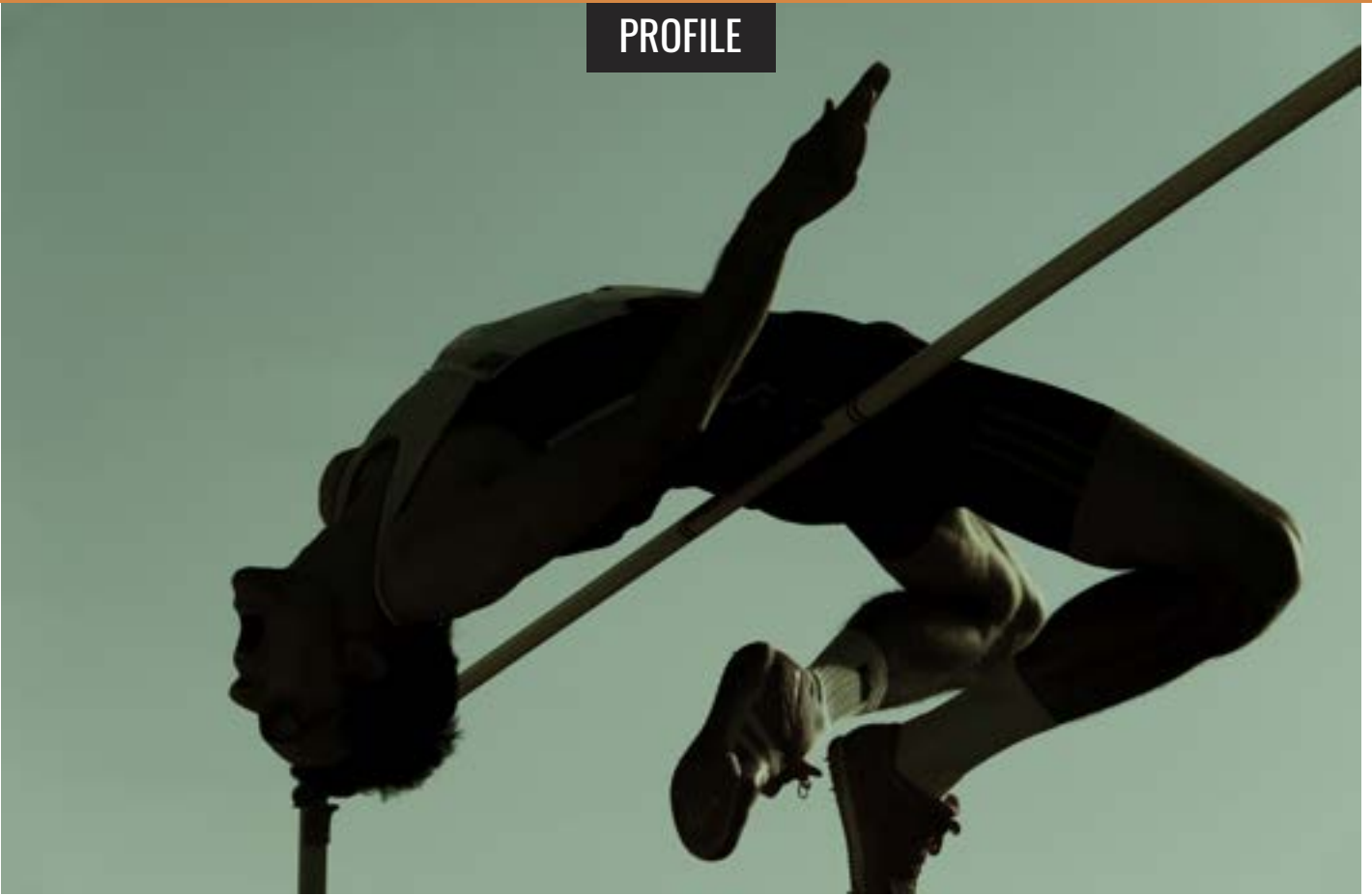
Tel: +41 79 247 1371

[tom.lyons@cryptovalley.swiss](mailto:tom.lyons@cryptovalley.swiss)

<https://cryptovalley.swiss/>

[www.twitter.com/thecryptovalley](https://www.twitter.com/thecryptovalley)





# Blockchain – a “Fosbury flop” for the insurance industry?

Jags Rao, from Swiss Re explores how a maverick mentality can turn the tables on tradition and have a global impact

**M**exico City, 1968. The Summer Olympics. And the scene is the men’s high jump final. The whole stadium was stunned when a 21-year-old lanky American called Richard Douglas Fosbury took Gold that day with a record-breaking jump of 2.24 meters. That in itself wasn’t so much the point but the manner in which he did it was. Fosbury jumped with his face to the sky. Until then, everybody did what was called “straddle” jumping facing the ground. His technique has since been famously called the “Fosbury flop”.

The athletics coach for the American team announced at the time that

those who followed Fosbury’s method risked breaking their necks. The only things that were broken were high jump records and the Fosbury flop has been almost universally adopted.

Uniquely, Fosbury challenged the status quo and adopted a style that contradicted the established convention. Decades later, his innovation is still discussed. And yet all he did, in fact, was to seek a better way of jumping over a high bar.

Fast-forward to January 2009 when a peer-to-peer electronic cash system called bitcoin network came into existence. This offered a unique way of

moving currency from point A to B without any intermediaries. It demonstrated that “trust” could be generated digitally from within the system. It contradicted the traditional process of building trust externally through intermediaries such as correspondent banks, clearing houses and sidestepped legal and regulatory oversight.

Much like the Fosbury flop, blockchain, the underlying technology behind bitcoin, challenged the status quo by offering an alternative that was fundamentally opposed to the traditional way of building trust. After over nine years the market capitalisation of Bitcoin continues to

soar to billions of US dollars, while the underlying blockchain technology continues to unravel its latent potential for the financial services industry and beyond.

So, what can blockchain do for insurance? In fact, the industry is financially healthy, but could operationally improve. It relies on multiple layers of counterparties generating “trust”, but with high frictional cost through their interactions. Over time, counterparties have improved operational efficiencies, but gains have been confined to “silos”. And the reality is that there still exists noise, friction, duplication, excessive paperwork and bureaucracy, with shared and common business processes leading to huge reconciliation costs and contract uncertainty. It is no surprise that this has contributed to the insurance industry’s not-so-customer-friendly reputation!

However, with the advent of cryptography, smart contracts and distributed ledger technology (blockchain), there are clear opportunities to tackle inefficient processes. The potential exists for commercial entities to track all their data-driven interactions securely on a smart-contracts resident on a blockchain without having to build different systems. Blockchain can enable the transaction flow across multiple layers of counterparties from original insured to brokers to reinsurers and all the way to capital markets. It could feasibly redefine the standard for digital transaction processing and deliver significant efficiency gains.

There are a number of experiments going on in the industry to test the hypothesis, validate the benefit and

convert prototypes into production-ready states. B3i, the Blockchain Insurance Industry Initiative, remains at the forefront of approaching this innovative technology with a clear purpose to bring real business change to our industry. This spirit around rethinking insurance is brought to life by some B3i members and captured on [video](#).

The formation and success to date of B3i is in itself breaking moulds. Formed initially by 15 insurers and reinsurers and later expanded to 38 market participants including brokers, the project has shown that where there is a common sense and purpose across the whole value chain, genuine collaboration is possible.

The project is an innovation and not just a dream. It has delivered hard results. In its first year, it moved from small in-house prototypes to an industry-wide global proof of concept and on to a market-tested property catastrophe excess-of-loss application in the largest industry-wide distributed ledger network to date. In 2018, B3i aims to transfer this into a self-sustaining entity to further develop and run the platform to settle legally binding contracts.

Nevertheless, there are a number of challenges ahead. Key issues such as collective standardisation, systems integration, legal and regulatory frameworks, privacy and confidentiality need to be addressed. However, the expected benefits in the form of reduced cycle time, cost and friction, as well as enhanced transparency, are hard to ignore as they are expected to create significant material savings.

Sharing these savings with the ultimate insured could help to drastically reduce the global protection gap.

The fact that over 7.5 billion people on our planet have no or limited access to insurance or cannot afford it, as much as anything else, provides an incentive to close this gap especially when the untapped premium could be as much as USD 800 billion. So, it is not just about increasing margins or improving service but providing an opportunity for social good and for a just cause. Let’s not forget that our role is to share the misfortune of the few across the many.

Much like the Fosbury flop, blockchain technology is once-in-a-generation kind of innovation, which if applied with clear sense and purpose as postulated in a [blog](#) by Paul Meeusen of Swiss Re, can make insurance more affordable, accessible and attractive for millions of underprivileged across the globe and make our world more resilient.



**Ken Marke**  
**Chief Marketing Officer**  
 B3i  
 Tel: +44(0)7766 202 832  
[ken.marke@B3i.tech](mailto:ken.marke@B3i.tech)  
[www.B3i.tech](http://www.B3i.tech)  
[www.twitter.com/B3i\\_tech](https://www.twitter.com/B3i_tech)

# Distributed ledger Blockchain technology for the financial services industry

We interviewed R3's Chase Gordon to learn about cutting-edge distributed ledger technology for businesses in the financial services industry today

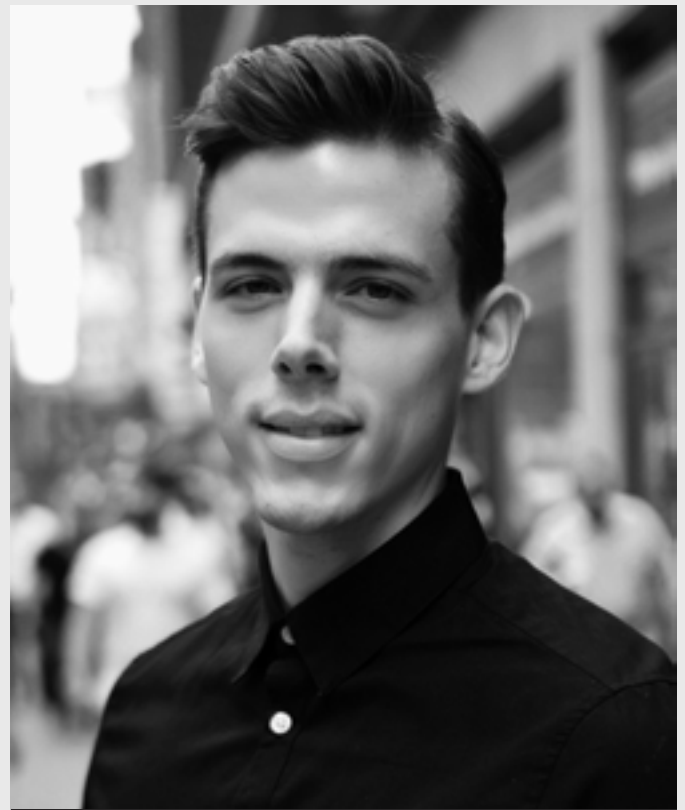
**R**3 builds cutting-edge distributed ledger technology for businesses. Corda, an enterprise-grade, blockchain-inspired DLT platform was designed by and for the financial industry, with input from over 100 banks, financial institutions, regulators, trade associations, professional services firms and technology companies.

This blockchain-inspired DLT platform was designed to meet the highest standards of the financial services industry, one of the most complex and highly regulated industries in the world, which also means it can be applied to all other areas of commerce. Applications of this blockchain-inspired DLT platform will in 2018 include, collateral lending, FX matching, syndicated lending and open account trade finance.

Chase tells us that other areas of application for such distributed ledger technology include insurance, reinsurance, healthcare and many more as the interview begins. He offers his thoughts on the role of Blockchain in the financial services world, first of all, in his own words.

"There are many benefits of using Blockchain in the financial services industry. The industry is known for using financial systems that date back 30 years or more, so it's not surprising that it has embraced Blockchain widely to improve upon such legacy systems. Blockchain enables the financial services industry to create better efficiencies and save money in the process.

"One of the key areas of financial services that blockchain can enhance is settlement of trades, which in some cases can take as long as a week, which is completely inappropriate for today's operating environment. Blockchain can reduce this time to minutes or even seconds.



*Chase Gordon, Associate at R3*

"In addition, blockchain can help the industry move closer towards full automation with the use of smart contracts that execute automatically once pre-set conditions are met. Our Corda platform uses smart contracts that link business logic and data to associated legal prose to ensure that the financial agreements on the platform are rooted firmly in law.

"This blockchain-inspired DLT platform is the foundation of a vibrant ecosystem of interoperable applications for finance and commerce. These apps are built by a growing network of partners, harnessing the power of DLT to overcome the specific challenges faced by their customers."



The conversation then moves to how one would explain distributed ledger technology to somebody with little or no knowledge of it, something that Chase is eager to explain to us.

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**“There are many benefits of using Blockchain in the financial services industry. The industry is known for using financial systems that date back 30 years or more, so it’s not surprising that the it has embraced Blockchain widely to improve upon such legacy systems. Blockchain enables the financial services industry to create better efficiencies and save money in the process.”**

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“Distributed ledger technology is essentially an immutable record of an agreement, which is secured cryptographically through hashes and keys, and it has an audit trail which is evaluated by separate nodes.

“On a traditional blockchain, each entity has its own node and information is shared to each of these nodes to validate a transaction. Corda tweaks this approach to data privacy and security by only sending data to those who have a “need to know.”

“This unique feature of Corda emerged from the requirements of financial institutions which need to ensure the confidentiality of trades and agreements, while also capturing the benefits of a distributed ledger infrastructure.”

In closing, Chase underlines the vital role that research and development (R&D) plays in the field.

“Back in September 2015, we launched an architectural working group with our members, which was the largest collaborative R&D effort in the industry. The learnings from this helped us to build Corda. We currently have around 60 R&D projects on the go and continue to use the findings from these as we ready Corda for commercial roll-out.” ■

**Chase Gordon**  
**Associate**

R3

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# Blockchain technologies for automatic regulation and compliance

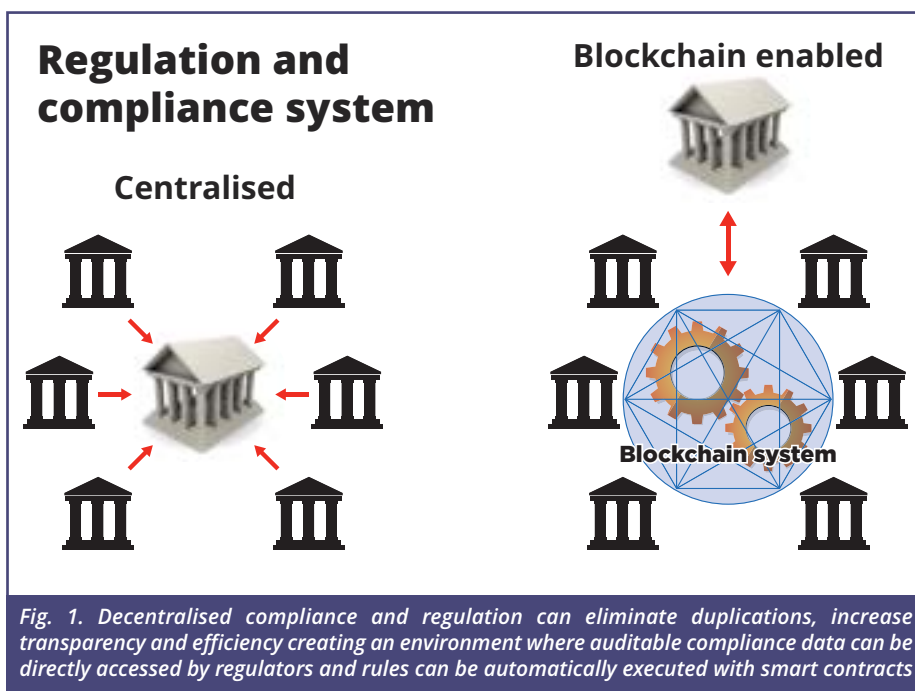
Professor Tomaso Aste from The UCL Centre for Blockchain Technologies shares his perspective on the use of blockchain technologies for both automatic regulation and compliance

**B**lockchain technologies have the potential to radically change compliance and regulation improving efficiency, reliability and transparency whilst redefining the services industry landscape generating new business models and radically innovating the present industry structure.

In the heavily-regulated financial sector, each financial institution maintains its own records on its own ledger system and reports data to the regulatory authorities accordingly with compliance rules. Over the whole market, this creates large duplication of efforts, lack of transparency and, unavoidably, inconsistencies that can cause litigations. These duplications and inconsistencies are associated with large costs and risks making the system inefficient.

Blockchain technologies can provide a transparent and secure environment where transaction records are made accessible to both industry and regulators. Through blockchain technologies and smart contracts, regulation and compliance can be automatised, thus removing strains from both regulators and industry while activating paths for new business models.

Blockchain technologies can reverse the way regulation and compliance are presently performed, creating an environment where both market players and regulators have access to



trusted auditable data relieving firms from compliance duties and compliance risks (see Fig.1). Blockchain technologies bring about the following main elements of disruptive innovation:

- Access to auditable data which are verified and hard to tamper with, creating time-stamped, immutable and historical records;
- Constitution of a transparent, interoperable environment where rules can be implemented, enforced and adapted by monitoring their effects in real-time and by using feedback from the participants;
- Provision of instruments to monitor and quantify both the reliability and reputation of users;

- Creation of a platform where rules can be encoded within the system – enabling automated review via audit software and;
- Create a unique source of truth approved by the community via consensus.

Furthermore, blockchain technologies can reduce counterparty risk, settlement risk and help to prevent fraud. They have potential to radically change risk management and fraud prevention with implications for regulation and capital allocation. Blockchain technologies have the potential to bridge the trade-off between a regulation that guarantees market stability and a regulation that boost financial innovation. This con-



vergence of industry and government interests is unique and as such, opens great opportunities. To this end, at a time when the financial sector is seriously investing in the development of these technologies, it is essential to develop an adequate research infrastructure to investigate the adaptation of blockchain technologies to regulation and compliance.

The general purpose of financial regulation is to forestall or alleviate the effects of market failure and promote innovations beneficial to public welfare. However, the ability of financial regulation to foster innovation in the services sector and financial sector, in particular, is challenged by the financial community that sees regulatory duties as detrimental to desirable change<sup>1</sup>. The Financial Conduct Authority, the Bank of England and their counterparts around the world face two linked transformative trends. One trend is the growth in the number of financial technology (FinTech) firms utilising cutting-edge technologies to offer innovative services.

The other trend is the prospect of using some of those same technologies to better extract and analyse firm and market information to enhance regulation, making it more efficient (RegTech).

FinTech firms are hard to monitor by means of traditional instruments. FinTech population is fast-growing: in 2017 the FCA has regulated around 60,000 financial services firms and markets, about twice the number regulated in 2013. A growing number of these services providers are new small firms that use cutting-edge technologies exploiting innovative business models. Given these proliferating number of platforms and interfaces, there is a clear and present danger that, without proper regulation, consumer risk and fair competition will be imperilled.<sup>2</sup>

In addition, the financial crisis increased regulatory complexity and heightened levels of supervision and, correspondingly, increased costs for both regulatory authorities and regu-

lated firms, including both incumbents and FinTechs. Automation in regulation and compliance can increase efficiency and decrease costs. Blockchain technologies can be the vehicle for such an innovation providing elements of transparency auditability and usability, by both regulators and industry that other systems cannot offer.

All industries and services are under some sort of regulation and they need to comply by reporting information to the relevant authorities and government bodies. The services sector contributes to 80% of the entire UK economy<sup>3</sup>, with the financial sector alone contributing £129 billion/year and the FinTech part generating over £20 billion in revenue every year, making the UK the world leader of the sector<sup>4</sup>. Automation in this sector will have a major economic impact on the economic prosperity of the UK.

In addition, although Blockchain technologies have been pioneered by the financial services industry, they have the potential for an even greater

## CBT

The UCL Centre for Blockchain Technologies (CBT) is a cross-disciplinary academic research centre established at UCL in 2016 to investigate blockchain technologies from a cross-disciplinary perspective. CBT research is based on three main pillars: Science & technology, economic & finance and regulation & law. It counts on the support of eight UCL departments, about 100 researchers and faculty members, fellows from all over the world and a large student community which counts about 600 units.

For further information: <http://blockchain.cs.ucl.ac.uk/>

## BARAC

BARAC is a research project funded in 2017 by the Engineering and Physical Sciences Research Council. Researchers from UCL, London School of Economics, KCL and University of Reading with background in computer science, economics, mathematics, business and law investigate the feasibility of using blockchain technology for automating regulation and compliance producing a proof-of-concept platform and facilitating knowledge transfer, by means of a bottom-up cross-disciplinary approach developed, together with industry and regulators.

impact on government. Indeed, blockchain technologies can create trusted, safe records of agreements and transactions and therefore applications for government are widespread. For instance, blockchain technologies can provide access to tamper-proof public records such as licenses, vehicle registration, passports or building permits and official records such as land titles, patents, certificates, degrees or HR records.

The use of blockchain technologies in the services industry and for the purpose of their regulation poses fundamental scientific and technological challenges. It rises also legal/regulatory and business challenges because players are asked to do a paradigm shift from trusting humans to trusting machines and from centralised to decentralised control. These new challenges demand an in-depth study of feasibility to test the soundness and applicability of ideas and approaches. There are indeed several open questions concerning how blockchain technologies can be used to develop better instruments to regulate services industry.

For instance, can blockchain technologies be scaled to the speed and size of financial data while preserving fundamental properties, such as community distributed verification and consensus? What is an effective model of governance of blockchain technologies systems that guarantees protection to consumers and fair competition? What are the legal implications for code misbehaviour? (Some codes might even be automatically generated within a distributed unsupervised system). And who will regulate/supervise the regulatory codes? Can blockchain technologies be made future-proof to preserve integrity and privacy, even when historic information stratifies and if some cryptography protections get broken in the future? These issues are currently investigated at the UCL Centre for blockchain technologies and within the EPSRC-funded project BARAC (see boxes).

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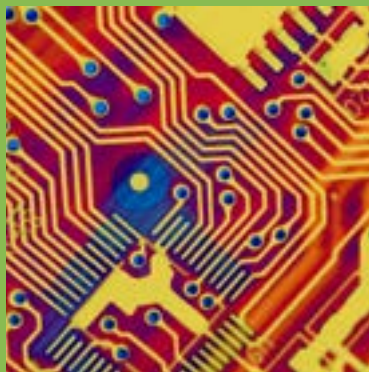
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### Professor Tomaso Aste

UCL Computer Science Department &  
UCL Centre for Blockchain Technologies  
[http://www.cs.ucl.ac.uk/staff/tomaso\\_aste/](http://www.cs.ucl.ac.uk/staff/tomaso_aste/)  
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# Are we ready for a blockchain world?

Marta Pierkarska, Director of Developer Ecosystem, Hyperledger asks  
if we are ready for a blockchain world in the future

**B**lockchain, the hype, the buzzword of the decade, the fairy dust that is supposed to solve all our problems. Technology that underlies Bitcoin and most other cryptocurrencies and is often confused with it. However, the umbrella of distributed ledger technology has applications beyond cryptocurrency.

Today, we see adopters in business environments in nearly every industry, ranging from financial and banking, through manufacturing and supply chain all the way to intellectual property, healthcare or real estate. Blockchain brings a promise of a secure, cost-efficient, transparent and easily auditable way to track any asset. Physical goods can be tokenised, traded and tracked through virtual peer to peer, distributed business networks without requiring a centralised point of control.

Hopefully, with the excitement around it, this technology can become pervasive in enterprises, government agencies and perhaps even the public sector. Why?

Because, at any time a community of organisations need to have a common system of record and build useful automation on top of it, so a blockchain will make sense. It cannot solve the issues of authenticity – we still need auditors to verify what is put on a blockchain but distributed blockchains in business settings will probably become the invisible backend piping that helps almost any industry. Most industries use transactions to get work done. Most industries have trust challenges. Most industries suffer from contracts being manually executed and assets being opaque.

Also, we find that most industries are looking for cost savings. We observe some fields being particularly eager to jump in and others are more in observation mode, but even the less brave ones have early adopters. The biggest challenge is lack of technical talent that can help with defining the use cases and deploy production system. This is a skill that will be highly relevant for many years to come.

What this all means for consumers is anyone's guess. Blockchain most probably will be completely invisible technology that just improves the systems we have today. Today, most users do not know that mobile devices include several chips and 2 operating systems. Many consumers don't even know what an operating system is.

Similarly, they should not be expected to know that the sustainably caught fish they ordered in a restaurant was tracked and certified with the use of distributed ledger technology, which meant it became affordable to them. The prospect for using this tech to go beyond a common system of record, to create actual digital assets on a chain (an insurance contract, an options contract, shares in a company, etc.) is very real and people are already piloting this.

We're encouraged to see so many regulators, banks, governments and others working to build up their own competencies in this space so that as industries start to implement their business processes as blockchain applications, the regulatory and statutory hurdles can be addressed. At Hyperledger, we're focused on creating an open framework for a cross-industry distributed ledger that can revolutionise the way we do business, increasing trust, accountability and transparency, while simultaneously streamlining business processes.

As with any technology, young or mature, we have challenges we are facing every day. There are issues around regulations and adaptability of the solutions – how do we plug new solutions into the existing legacy systems, even if we know that there are huge benefits to it, the technical questions still need to be answered. What stops many enterprises from moving from POC to deployment is performance, scalability and interoperability.

We need mature stable technologies and techniques for scaling transactions across chains. This is true even in a consortium chain setting, where you can achieve much higher transaction rates than on the public chains. Getting to tens of thousands of transactions per second across geographically diverse networks with non-trivial validation logic running on each node will be an architectural and design challenge for developers working in this space.

The good news is there are many use cases requiring lower transaction rates (land titles, medical records for a small country, supply chain flows for a given industry) and developers at Hyperledger are working on solutions for addressing scalability. This is just a function of time. This technology is still very young and we're still addressing the management, monitoring and design challenges – what you might call the “DevOps of blockchain.” We'll expect substantial progress in 2018, but these are still early days.

So, are we ready for a world powered by blockchain? Are we ready to usher in a new trustless paradigm, where people no longer need to trust organisations but instead trust the software? I think so – it's not too crazy to think that in the next 5 years, nearly every Fortune 500 company will have a distributed ledger as part of their back-end system somewhere. However, let's remember – blockchains are based on a peer-to-peer network, so you need peers to build that a common system of record. In this space, we need to collaborate and interoperate.

It also means that anywhere where a company participates in a network of trading partners, a supply chain, a regulated market, etc., then they likely will see an operational and strategic investment in blockchain tech. I have some personal wishes. I wish to be able to manage my personal healthcare records through a “wallet” of some sort. I wish to have inter-bank or even international payments settle immediately rather than over the course of days.

I hope that the provision of government services – particularly when it comes to property registry, permits, voting registration and other process/transactional touch points – will dramatically change. Most of all I hope that blockchain will bring people closer than before – collaboration and cooperation for the better of mankind and especially that we will not have just a single blockchain to rule them all. ■

**Marta Pierkarska**  
**Director of Developer Ecosystem**

Hyperledger  
[info@hyperledger.org](mailto:info@hyperledger.org)  
[www.hyperledger.org](http://www.hyperledger.org)  
[www.twitter.com/hyperledger](https://www.twitter.com/hyperledger)

# Blockchains, trust and power: Governance models of the future

Sari Stenfors, PhD from the ReCon Blockchain Research Project at Aalto University looks at how distributed and open technologies transform our interactions

In a forward-looking research project at Aalto University's Business School in Helsinki, together with partner companies and public organisations such as the Finance Ministry of Finland, we are studying one of the future change drivers, blockchain technology. Much media attention is given to blockchain and its best-known use case, Bitcoin. However, the most impactful business and societal implications of blockchain are yet to be discovered, despite ongoing experimentation ranging from finance and logistics to healthcare and beyond.

## The power of blockchains

Different types of blockchain technologies and other decentralised ledger technologies are important building blocks of our future. When they are combined with AI, AR/VR, IoT, robotics or 3D printing, they provide completely new ways to set up the societies we live in. They hold the potential to disrupt not only the internet, but the way our societies are governed and what we know of as the current way of doing business. The impacts could be vast. Blockchain technologies are already being applied to the fields of finance, government, IoT, energy, accounting, logistics, insurance, healthcare, education, record keeping and governance.

Why are they so powerful? Blockchain technology is a novel data-architecture. We live in the data-driven era. The most important businesses, such

as Google and Amazon, are about data. Blockchain technology stores data in a decentralised way in multiple computers to make sure it is not tampered with. There are hundreds of different decentralised ledger technologies today and their governance structures ensure that a single computer cannot decide what data is stored. This way, we can trust that the stored information will not be corrupted by a party that would benefit from it. The system creates programmable trust.

## Trust in the data-driven society

Trust is the building block of any transaction and our society is based on transactions. If there were no trust, we would not dare to make any transactions. To ensure trust, we have traditionally done business with people and businesses who we were familiar with, or if that was not possible, we used third parties to ensure trust.

In a data-driven society, we would like to find trust fast, at the location of the transaction and with low cost. The availability of internet and all the different mobile apps have opened up a possibility to engage in transactions with far more people and businesses than the generation before us did. We cannot know all of these new business partners and if they broke their part of the deal, how would we go after them? It is costly to be cheated, so there is a price for being able to prevent it, i.e. trust. Also, the market for

trust has grown as there is more demand for it. Traditionally, for example, banks, agents, referees or custodians have been able to take high fees in exchange for trust. However, the market mechanisms for buying trust as we knew previously, do not serve us anymore. Trust needs to be more readily available and have a lower price point per transaction. There are two new solutions to trust: reputation systems and blockchains.

## Governance models of the future

In 2008, an unknown author with the pseudonym Satoshi Nakamoto wrote a whitepaper which described the governance model of the bitcoin blockchain. It detailed a governance structure that enabled a currency without a central authority watching over it. That introduced new power structures to the financial world. It showed that blockchains can change business models and governance systems. Potentially, we could do all transactions in peer-to-peer networks and third parties would not be needed anymore.

Today there are a variety blockchains with a variety of governance systems. There are also different types of options on who is allowed to access and store data on them. There are public blockchains, federated blockchains, private blockchains, permissioned and permissionless blockchains. Generally, the more



“Much media attention is given to blockchain and its best-known use case, Bitcoin. However, the most impactful business and societal implications of blockchain are yet to be discovered...”



closed the system is, the more focused it is on creating process efficiencies for a defined number of users. For giving more power to the larger community and for creating new business models, the blockchain governance systems need to be more open and permissionless. Blockchain-based identification systems can further enhance novel governance structures, by giving the ownership of data to the people who created it. There are numerous ways to enhance and redesign blockchain governance systems to better fit our understanding of fair societies.

## An opportunity

Blockchains will be part of our lives. It may take even a decade to develop the infrastructure to the point that blockchains will be mainstream. They are over-hyped and as such, many pilots will fail. The beginning will be

slower than what we expect, but they are here to stay. Before long, blockchains will be used in everyday lives and they will dictate how we are governed.

How we create trust and whom we trust, how we exchange value and how power is distributed will be completely transformed. We are still at the beginning of the blockchain era and it is a good time to affect the governance of a society and to reimagine how it could serve you in the best possible way.

## Our research

These are the types of questions that we at the ReCon research project are thinking about and experimenting on. Certainly, we engage in pilot projects, hackathons, studies, workshops and keynotes. Our mission is to describe, analyse and experiment on the poten-

tial societal impact and new business models of blockchain-like technologies. More information regarding the ReCon research team and our partner organisations can be found at <http://recon.site/>



**Sari Stenfors PhD**  
**ReCon Blockchain Research Project**  
 Aalto University  
 Tel: +358 50 496 7134  
[sari@alead.com](mailto:sari@alead.com)  
<http://recon.site/>





# Relaunching the digital single market: Banning geo-blocking

Lambert van Nistelrooij, a Dutch Member of the Internal Market and Consumer Protection Committee (IMCO) of the European Parliament explains his opinions on banning geo-blocking

**T**he digital single market in Europe doesn't work as it should. Not only the striking differences while renting a car at an airport in the EU made headlines. A public consultation by the European Commission found that close to 90% of consumers have experienced geo-blocking.

Many European consumers experience different prices and conditions when buying goods or services abroad, in particular via the internet. In my opinion, it's high time to ban this.

The EU is realising a law to correct this starting from the end of 2018 – the geo-blocking regulation. Its aim is to make online shopping work like offline shopping, where consumers from everywhere are generally offered products or services at the same price and conditions.

## **Speeding up the (digital) single market**

The purpose of having a single market, for consumers, is better prices and more choice through competition. Geo-blocking prevents just that. Take for example a Dutch consumer that wants to buy a website hosting service from a German company. Until now, the German company could deny access to its services or charge higher costs because of the customer's location.

From 2018, the company cannot decline nor charge a higher amount. Under the new rules, online sellers will not be allowed, much like their offline colleagues, to discriminate between EU consumers when it comes to terms and conditions and prices based on their nationality, place of residence or even their temporary location.

So, EU buyers abroad will finally be treated like locals, like with the successful EU roaming rules for mobile



phones. With the high growth potential of the digital single market, we speed up the European integration to the benefit of the consumer.

### What's in it for you?

The new regulation will cover 3 different dimensions: electronically-supplied services, goods without physical delivery and services provided in a specific physical location. Without paying more, buyers located in other EU countries than the traders' will be able to:

- Buy goods when the trader does not deliver them to your home country. There should be an option to collect the goods at an agreed location or pick them up yourself. However, there will be no obligation to deliver across the EU for companies.
- Make a booking (hotel, sports events, car rental,

## ICT

music festivals or leisure park tickets) abroad under the same conditions as locals. Renting a car, or booking a weekend to Disneyland, prices and conditions may no longer vary based on nationality or residence.

- As a basic rule, automatic re-routing to another (country-specific) website without the consumer's prior consent will not be allowed. If consumers in Belgium specifically want to check the webshop of Ikea Germany for example, they should be able to inform themselves there.
- Regarding payments: traders will no longer be allowed to request that consumers should possess a debit or credit card from a specific country to make a purchase.

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**"The digital single market in Europe doesn't work as it should. Not only the striking differences while renting a car at an airport in the EU made headlines. A public consultation by the European Commission found that close to 90% of consumers have experienced geo-blocking."**

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In closing, I would like to say that the geo-blocking regulation is a significant step forward in further realising the potential of the digital single market. Now that there is an agreement with the European Council, online consumers have similar rights as locals. The European Parliament will formalise this position in the coming months. ■

### MEP Lambert van Nistelrooij

**Dutch Member of the Internal Market and Consumer Protection Committee (IMCO) of the European Parliament**

Tel: +31 70 342 48 20

[lambert.vannistelrooij@europarl.europa.eu](mailto:lambert.vannistelrooij@europarl.europa.eu)

[www.lambertvannistelrooij.nl](http://www.lambertvannistelrooij.nl)

[www.twitter.com/LvNistelrooij](https://twitter.com/LvNistelrooij)

# Leading the digital transformation of UK government

Kevin Cunnington, Director General of the UK's Government Digital Service (GDS) provides a fascinating overview of how the organisation's work is leading the digital transformation of government

**T**he Government Digital Service (GDS) is part of the [Cabinet Office](#) and our job is to help government work better for everyone.

We actively support every government department and agency in the UK, as well as organisations across the public sector, to help them deliver excellent digital services which meet user needs. Our work over the past six years has given the UK the reputation of the world's leading digital government.

## How GDS is leading the digital transformation of government

GDS leads the digital transformation of government in a number of ways. We develop, publish and monitor the [Government Transformation Strategy](#), published at the start of 2017 which sets out how the government will use digital to transform the relationship between the citizen and state. We provide the tools, skills and techniques needed for that to happen.

People are the foundation of our work and without the right people, transformation can't happen. We provide the skills to enable transformation, for example, through training at the [GDS Academy](#).

A big area of focus for us is making sure that government is made up of digital professionals who can deliver world-class services which truly benefit the lives of the people it serves. Doing so will ready us for the opportunities and challenges of the 21st century.

GDS has created components that solve common problems across central and local government and the public sector. We call this toolkit Government as a Platform (GaaP). It includes GOV.UK Notify and GOV.UK Pay.

GovWifi allows staff and visitors in government organ-

isations to connect to a secure wifi service whilst they move between government buildings. In November it exceeded two million transactions.

In terms of techniques, a number of major transformation projects are being delivered across government. We ensure that teams are able to deliver these using agile methodologies

## The role Agile plays in GDS's work

The government needs to be able to respond quickly to change. Agile and GDS have gone hand-in-hand from the start. Agile methods encourage teams to build quickly, test what they've built and iterate their work based on regular feedback.

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**"GDS leads the digital transformation of government in a number of ways. We develop, publish and monitor the Government Transformation Strategy, published at the start of 2017 which sets out how the government will use digital to transform the relationship between the citizen and state. We provide the tools, skills and techniques needed for that to happen."**

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Agile also supports our work on openness and transparency. If you visit the GDS office, you'll see that most of our wall space is taken up with Agile walls. These give an open view of our work: everyone in the office can see what other teams are working on, their progress, where bottlenecks are. It encourages discussion.

## The work GDS does as a centre of excellence in digital, technology and data, collaborating with departments to help them with their own transformation

There are two examples of ways in which we work with departments to help with their transformation. Firstly,



*Kevin Cunnington, Director General of the UK's Government Digital Service (GDS)*

the building of new digital services using our common platforms.

Secondly, as part of the wider government strategy, we're now undertaking a project that will help us be more strategic and focus on our capability-building.

A single workforce plan is being created across the digital data and technology profession. This will help us to identify gaps in skills and diversity across government. It will also give us a benchmark to measure progress.

The Prime Minister, Theresa May, recently announced the creation of a £20 million fund to drive the development of new technologies in public services. GDS plays a central role in the allocation and administration of this fund. Funded projects will have embedded GDS innovation specialists who ensure value for money and make sure they link up with other similar projects

Examples of key innovations include AI, ML, biometrics, geospatial, distributed ledgers, Internet of Things (IoT) and augmented reality (AR) and virtual reality (VR).

### **How GDS works with rest of government to make public services simpler and better**

Collaboration is central to this. We are committed to

creating an environment in which working together is the norm. GDS has a role in bringing people together because we believe this is how the biggest savings and improvements happen.

GDS also administers standards to help government create and run good digital services. They include the [Digital Service Standard](#); the [Technology Code of Practice](#) the [Cabinet Office spend controls for digital and technology](#) and [Open standards](#).

Our cross-government communities also provide an opportunity to learn from each other and share best practice. ■

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### **Kevin Cunnington Director General**

Government Digital Service (GDS)

<https://www.gov.uk/government/organisations/government-digital-service>

[www.twitter.com/gdsteam](https://www.twitter.com/gdsteam)



# Govroam – the wi-fi network linking public services

Mark O’Leary from Jisc shares his expert perspective on govroam which provides the possibility of “zero-touch” access to wi-fi

Anyone who has to travel to different offices and buildings regularly as part of their job will understand what a pain it can be to swap on to different wi-fi networks at every new destination. Identifying the correct network, sourcing the password and logging on all takes time and effort.

In the public sector, where partner-working across different sites and organisations is increasing, “zero-touch” access to wi-fi has become a possibility with the launch of [govroam](#).

It means that public sector employees across the UK can now travel between any participating public services’ building and connect to the network, without touching their laptop, smart phone or tablet. Once the profile is installed, the connection happens automatically.

## How does govroam work in practice?

The introduction of govroam supports the trend towards multi-disciplinary activities, such as the convergence of health and social care.

Site-sharing with govroam enables multiple organisations to share a physical location and connect over a single standardised network. Parts of a council office could be repurposed for community-based police or health workers, or spare space in police stations made available for probation



staff. This approach encourages collaborative working and has considerable cost-saving benefits, too.

## Scenarios where govroam would prove useful include:

- A multi-disciplinary meeting to organise a community rag week, where police and ambulance staff, highways and other council workers, plus the local MP might all meet at the university to talk to the student union, all using their own online resources back at base to plan, schedule and research.
- A school where health visitors attend to immunise the children, police visit to teach road safety and council workers provide estate services and meal deliveries etc.
- An elderly person is recovering in hospital after an assault and while there, needs contact with social services, community health workers and the police.
- Heavy snowfall prevents council workers from reaching their building, but by prior arrangement, they can get to the local fire station and temporarily work from there.
- An international event like Tour de France comes to town and outdoor govroam coverage allows coordination between police, medical and council staff to manage the crowds.
- A health trust organises a conference for doctors from all over the country and doesn't have to budget



or plan for networking, as there is already govroam in its conference centre.

- Council workers can use any room in the building for tasks that require connectivity, not just designated areas.

## Who's using govroam?

Such multi-tenanted sites are already being used in Leeds, where govroam is in place as part of the Yorkshire and Humberside Public Services Network (YHPSN).

Another PSN that has adopted govroam is Kent, where every local authority in the county has rolled it out; govroam is now available at more than 250 sites and rising and work is continuing to connect the whole of Kent's PSN, which has more than 370,000 users across nearly 1,200 sites.

Govroam has also been deployed in parts of London and there's a new

lobby group, Connectivity Over London, which is looking to champion the use of both govroam and its sister service for the education sector, eduroam, across the capital. This would link hundreds of universities and public-sector locations.

There is also keen interest from PSNs in many other parts of the UK. The service is not, however, limited to PSNs: the fastest growing adopter of govroam to date is the NHS.

## Background and further info

Govroam evolved from eduroam – the established wi-fi service used by the further and higher education and research sector and which runs on the UK's national research and education network, Janet. Eduroam supports the roaming of 1.6 million unique devices each month. This network is operated by Jisc, the UK's education technology not-for-profit, which has used its experience of eduroam to develop

govroam. Jisc has produced a [podcast](#), a [film](#) and an [animation](#) about govroam and has [further information](#) on its website.



**Mark O'Leary**  
**Head of Network Access**

Jisc  
Tel: +44 (0)1235 822 371  
+44 (0)7545 165 975  
mark.o'leary@jisc.ac.uk  
govroam@jisc.ac.uk  
www.jisc.ac.uk/govroam  
www.twitter.com/markoleary



# Is cyber security your biggest digital risk?

Patrick Arben, partner at Gowling WLG reveals his thoughts on the ever-prevalent issue of cyber security

Cyber security is certainly a digital risk that is 'of the moment' as recent headline attacks have helped to highlight the issue and bring it to the fore. Indeed, the rapid onset of the digital age and smart mobile technology means that criminal activity can take place far more remotely than ever before – increasing the risk of an attack in the process.

Putting preventative steps in place before the fallout has to be dealt with is therefore highly advisable. However, it is important not to get lost in the headlines and recognise that this is just one digital risk amongst a range of others that business owners must be aware of and protect against with exactly the same level of urgency as for a cyber-attack.

Highlighting an inherent need for this is a recent survey of 1000 business throughout Europe by Gowling WLG. UK respondents identified far fewer digital risks as a threat to their business when compared to the views of their European counterparts. Although it is never a good idea to ignore other digital threats, addressing the risk around these now could well pay dividends.

## Identity theft/cloning & loss of data

Whatever uncertainty exists politically at the moment, the UK will be adopting the EU General Data Protection Regulation ("EU GDPR") and updating our own Data Protection Act. This has a direct bearing on the way that personal data is stored and processed and the necessary permissions that will need to be sought, businesses will already be looking at their data storage processes and policies with a view to these falling in line with the new legislation.

A good idea, therefore, is to (in conjunction with the general audit) conduct a compliance/risk assessment of the most important/relevant data that could be stolen and develop controls and processes that help address these risks. Also, the creation of scenario planning that establishes how a security breach incident will be addressed if it occurs can really help ensure that responses are swift in the event of this occurring.

From the customer's perspective, online privacy and security have fast become a major USP, as consumers are now savvy enough to think with their feet and





*Patrick Arben, Partner*

choose another provider for a product or service, should a provider's reputation for data security be impacted. It is precisely because a serious data breach if it becomes public, can have such a serious impact on a business's reputation and bottom line that organisation need to treat this threat as a priority:

- Ensure all departments are briefed on the importance of customer security so there is a shared, unified approach;
- Encryption efforts change rapidly so it is important to be up to date with the latest methods and implement these accordingly;
- Limit access to customer data to those that actually require it;
- Ensure that bring your own device (BYOD) policies for staff – establish a policy that requires employees to provide notification in the event of a lost or stolen device so that measures can be taken to prevent data loss and;
- Ensure there are several layers of online security so there is back up if one fails.

## **Lack of sufficient technical and business knowledge amongst employees**

This is, of course, a key digital risk to consider, given that the actions of one employee could make all the processes and strategies that are put in place to protect against digital risk redundant. It is therefore important to see these types of risk as imminent threats to the business which everyone must be aware of protecting against. Implementing a cascaded programme of education about this throughout a business is therefore highly advisable to drive awareness and a sense of personal responsibility throughout the workforce.

## **Infrastructure issues**

A robust digital infrastructure is the most vital component where making the most of the data that is housed within a business is concerned and use it as something to transform successes.

Optimising data in the best way means more than collecting, storing and processing bits and bytes. Ensuring reliability and security across a stable network will help to turn data into actionable information and further protect it from outside attacks – thereby helping to protect and promote the organisation in one fell swoop. As well as handling increasingly large volumes of data, an efficient digital infrastructure can help overcome network and connection problems and help implement governance around digital activity.

## **Regulatory issues**

As the GDPR and data protection points above highlight, compliance with the law is vital in terms of protecting the business from fines that could have been avoided if the right preventative steps had been taken in advance.

## **In conclusion...**

So, by being extremely proactive in this area, businesses succeed in complying with the law, protecting themselves against digital risk and transforming their operations, if the right digital infrastructure is in place. ■

### **Patrick Arben Partner**

Gowling WLG  
Tel: +44 (0)121 393 0011  
[patrick.arben@gowlingwlg.com](mailto:patrick.arben@gowlingwlg.com)  
<https://gowlingwlg.com>  
[www.twitter.com/GowlingWLG\\_UK](https://twitter.com/GowlingWLG_UK)



# Digital transformation helps central and local government make resilience a reality

Sungard Availability Services Ltd explores the pressure central government departments and local authorities are under to achieve more with less and how digital transformation can help to achieve their business outcomes

**W**ith spending cuts and population growth a reality, central government departments and local authorities alike are under pressure to achieve more with less. In response, many are forming new partnerships, adopting innovative ways of working or embarking on digital transformation projects.

Finding they lack the resources or specialist expertise in-house, some central government departments and local authorities are turning to Sungard Availability Services, a leading provider of custom production and recovery IT services, to help them achieve business outcomes. Sungard AS successfully partners with government departments, local authorities, housing associations and other public-sector organisations to transform the IT infrastructure underpinning public services and improve organisational resilience.

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**“Gone are the days when businesses, residents and taxpayers would tolerate downtime while a heroic recovery was executed.”**

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Many organisations believe they have protected themselves from business disruption by implementing a business continuity plan. But that is no longer enough. Gone are the days when businesses, residents and taxpayers would tolerate downtime while a heroic recovery of IT systems was executed. Today's

citizens expect the organisations they deal with to be always-on, which means public sector organisations need to be both agile and resilient. The government needs to be able to handle change and deliver expected services without interruption, regardless of any obstacles encountered.

In the past, IT systems that were rigid, slow and expensive to change were a barrier to achieving this goal. With organisations today almost completely reliant on technology, there is little incentive to make other parts of the business agile when anchored to IT systems that are rigid, slow and expensive to change.

However, cloud computing offers the agility, flexibility and lower lifecycle costs that free the rest of the organisation to adapt to withstand and even flourish, in response to change.

Sungard AS is constantly evolving its service offering to meet customer needs. Isolated Recovery, a recently introduced service, is one such example:

## **A successful recovery starts with clean backup data**

On average, cyberattacks can remain undetected for up to 99 days. This means there is the real prospect of an organisation having no clean backup data available with which to perform a recovery. To address this, Sungard

AS developed its Isolated Recovery solution for customers' critical applications that need an additional layer of protection.

Platform and operating system agnostic, this service enables customers to create a 'gold copy' of critical backup data in an Isolated Recovery vault in a separate, secure location. As data is replicated to the Isolated Recovery vault, customers can perform malware forensics and manage the risk of corruption.

Once the backup process is complete, the direct network connection to the Isolated Recovery vault is air-gapped or shut down. This isolates the gold copy from the network and prevents corruption. Organisations then have a safe backup to restore their data without fear of replicating the malware in the recovery process.

Lastly, because the Isolated Recovery vault stores multiple gold copies, all with retention lock, a rollback to days or weeks beforehand is possible if needed.

## **Council benefits from flexible, agile and resilient IT at lower cost**

Enfield Council was prompted to embark on a programme of digital transformation when its contract with an outsourcing provider came to a premature end. The forward-thinking local authority saw it as an opportunity



to grasp the flexibility and cost-savings achievable through exploiting cloud technologies. A seamless transition, with no degradation of services, was essential.

With the time being of the essence, the council turned to Sungard Availability Services, its longstanding disaster recovery provider, to guide it through a phased transformation programme. This involved helping the council transition to the Microsoft Azure cloud within an aggressive timescale and hosting remaining legacy systems in a secure, resilient environment. The migration was executed on time and within budget, so smoothly that those council employees were unaware that it had taken place!

Enfield Council is now benefiting from highly available and secure infrastructure with SLA-backed levels of uptime, lower IT running costs and greatly enhanced flexibility and scalability. As well as anticipated headline savings of 30%, it also has more predictable IT infrastructure spend with costs moving from the CapEx to OpEx budget and greater cost-effectiveness as it pays only for services used.

### **Government department retains control without the headaches**

Sungard AS also works with central government departments to achieve their 'cloud first' ambitions. One key department needed a cloud partner it could depend on to host four important applications and provide a disaster recovery service to minimise downtime.

It contracts Government Cloud Services from Sungard AS, which has been Cyber Essentials Plus-certified, via the Digital Marketplace. Under the G-Cloud call-off contract, Sungard AS provides the department with an enterprise-class, multi-tenancy, IT infrastructure in a secure hosted environment, resiliently connected. This means the department retains control over its all-important applications without the burden of owning and managing the underlying infrastructure. While this comes with the assurance of 99.99% uptime, the department contracts Cloud-Based Recovery to cover its hardware and operating system.

OFFICIAL data is hosted within two UK-based data centres, supported around-the-clock by a dedicated,

security-cleared operations team. In addition, the department can scale up quickly and easily according to demand.

Of course, some legacy systems are not suitable for the cloud so Sungard AS works with whatever infrastructure the organisation has, including the most complex Hybrid IT environments, providing comprehensive consultancy support.

To find out more about Sungard AS' services, call +44 (0)800 143 413 or email [Government@sungardas.com](mailto:Government@sungardas.com).



# Cybersecurity predictions

VP and Chief Security Officer, EMEA of Palo Alto Networks, Greg Day shares his cybersecurity predictions for the future. Beyond his work there, Greg also sits on the UK National Crime Agency steering committee

Cyber adversaries will extend further into ransomware, OT systems and cryptocurrencies. In recent years we have seen ransomware used for profit. However, RanRan is an example that used concepts of ransomware, not just for profit, but also to identify information that could be used to blackmail victims. While continuing to be financially focused, I believe ransomware will also start to do more data analysis, which means we could see ransoms based on data value, rather than being generic, plus more of both targeted ransomware attacks and those being used for other motives, such as blackmail.

The Dyn DDoS attack leveraged IoT devices to attack traditional computer systems. The volume of OT (operational technology) is growing at pace, whether that is factory systems or automated drones delivering medical supplies in countries like Africa and we have yet to see the impact of such systems coming under direct attack. However, the value to criminals of stealing medical goods will surely mean that they look to break into the IoT or OT system to redirect the goods and this highlights the challenge we are likely to face. The growing commercial utilisation of IoT and OT systems means that, for the adversary, the value of breaching and controlling these types of systems is increasing.

Finally, with the growing popularity of digital currencies, more commonly known as cryptocurrencies, we can expect to see more malware focused on stealing account information to empty these next-generation accounts. The second payment services directive (PSD2) requires payment processors to open access to third parties and as discussions continue around blockchain digital ledgers, it feels as if the financial industry is moving further towards the digital money space. The question is whether adversaries are prepared for this transition – evidence would suggest they are already looking at it.

Cyber attacks' impact will change. With some of the ransomware attacks in 2017, in which medical facilities were impacted, cyber incidents are now having real-world, physical impact on people. With the growth of digital twinning (creating a digital counterpart to an existing process or system), we can only expect more of the same affecting many more facets of everyday life.

So how does that change cybersecurity? It's very probable that we will continue to see even more regulation step in to continue to drive baseline security higher and ensure confidence in cyber systems that impact society. The Network Information Security (NIS) Directive, which goes live in 2018, includes a new "digital service providers" category. As cyber has a greater physical impact on society, we must expect to see more categories along these lines being developed, beyond the traditionally defined, critical national infrastructure, or operators of essential services.

In this context, the role of security leaders, such as the CSO, must evolve. If there is harm to citizens due to technology failure, there will likely be public requests to understand if and why there was neglect, who bears responsibility and what relevant actions must be taken.

Consequently, while just a short time ago CSOs were often worried about being fired considering an incident, liability may become more of a concern in the future. Could this lead to CSOs requiring professional insurance in the same way as many medical practitioners do today? Might we see a longer-term requirement for formal qualification and registration to be a practicing CSO, much as others who protect human lives – such as doctors – have today?

Credential theft will target weak collaborative cloud points in the supply chains of all kinds of businesses. Whether it's because of the cloud or just the dynamic



nature of a business, it seems we are only increasing the interconnectivity with our partners, supply chains and customers. The challenge here is working to maintain your own cybersecurity capabilities, while also looking at how to manage the risks that stem from the unknown others (partners, supply chain, etc.).

An IDC session I attended early in 2017 highlighted that the number of information-based industry-collaborative clouds will increase fivefold between 2016 and 2018. As such, while adversaries continue to look for an entry point into the business, it seems likely and logical that collaborative cloud spaces may be their next doorway in. As such, businesses must start to consider what information they include in these spaces, how they validate the use of connected third parties, so they can spot anomalous behaviour and – most importantly – look at how they segregate such connection points from more critical, internal business systems, using methodologies such as the Zero Trust model.

Twenty-year-old first principles are finally reset. Many of the guiding principles in cybersecurity haven't changed much in 20 years. Typically, practitioners have strived to solve every problem to the best of their abilities, using the best solutions available at the time.

However, significant changes in IT consumption models – dynamic, agile systems that are increasingly disposable in nature and based around subscription billing – mean that businesses will no longer continue to buy and build separate siloed cybersecurity solutions that require significant capital expense and people skills and

are based on multi-year cycles. As such, the fundamentals of cybersecurity consumption will change.

Functioning in such dynamic environments requires cybersecurity to be native and automated, to both work and adapt at the same pace. This doesn't mean we won't still have choices of technology capabilities and vendors – you only must look at the AWS marketplace to see how this is the case. But this does mean that native security will require dynamic enablement, configuration and transposition. In the past, security often failed as businesses struggled to connect their own insights; in an agile IT world, the importance of having a consistent and integrated point of visibility, combined with automated control, will become critical.

The transient nature of increasingly consumable IT creates a further hurdle, which is that, by the time an incident is discovered, the environment in which it was instigated may no longer exist. As such, you need to be able to understand how and why the incident occurred and what was achieved, when operating in an increasingly regulated world. This will lead to greater demand to maintain historical logging data and for the correlation required to leverage it. ■

**Greg Day**  
**VP and Chief Security Officer, EMEA**

Palo Alto Networks

[www.paloaltonetworks.com](http://www.paloaltonetworks.com)

[www.twitter.com/GregDaySecurity](https://twitter.com/GregDaySecurity)



# How do we build safer digital environments?

Identify, Protect, Defend, Respond are the four key components to ensure safer digital environments. Here, Fujitsu provide insight

A decade ago, primary security concerns were satisfied by deploying and maintaining an effective firewall, in addition to keeping the permissions for devices and physical locations up to date. While organisations used the internet to maintain a website and for communications, an online presence wasn't as ubiquitous as it has become today.

How things have changed! Today users expect to access information and departments on any device – and to do so from almost anywhere, at any time. Information really has become the new currency – and it's available 24x7. It is commonplace today that employees bring their own devices into the organisation's network, download and install software they have selected, and interact with corporate data on their own personal devices. What's more, these devices are taken outside the workplace – still carrying access to valuable and sensitive data.

Citizens want to be empowered to reach services as and when they desire which creates huge challenges for national and local bodies to provide platforms that are resilient and information that is protected. The issues of data management, storage, access, and rights need to be paramount within any business or organisation where there is a transaction of information.

This new level of being interconnected brings untold benefits but it also

creates new security challenges.

Against this backdrop, Fujitsu's Global Cyber Security business protects government departments around the world against cybercrime of all kinds, strengthening their resilience against cyber-attack, as part of a globally-integrated security offering.

Fujitsu provides Managed Security Services from Security Operation Centres (SOCs) in Japan, North America, UK, Germany, Finland, and Spain, and aims to bring to market a wider range of security solutions, upgrading its SOC's to Advanced Cyber Threat Centres.

## **Our philosophy: Identify, Protect, Defend, Respond**

Fujitsu's portfolio of security solutions and services provides public sector organisations with peace of mind that their security is in good hands while they get on with running their business. Fujitsu aims to be the trusted digital security services provider, helping its customers predict and respond to cyber threats to protect their business reputation with an intelligence-led approach.

Our key services lie in 3 areas:

- Predictive intelligent threat detection;
- Trusted delivery - expert-led professional and managed security services;
- Global 24x7 monitoring & response.

## **Managed Security**

One key service that Fujitsu offers to address this lack of time and skills is a fully managed security service. A key feature of this is continuous system monitoring that constantly keeps a watchful eye on internet traffic, looking out for potential attacks before they can do harm.

Fujitsu takes an intelligence led-approach to cyber security. Artificial intelligence systems monitor customers' internet traffic for potential risks. Once identified, the team of experts located in one of the global SOC's can help customers rapidly take action.

## **Advanced Biometrics**

Security challenges are not limited to the cyber world and the implications of sensitive information falling into the wrong hands remain significant. The most basic level of prevention involves controlling physical access to hardware or facilities. Traditionally, access to doors, devices, computers, and border controls have been managed by PIN code entry systems or by door tags – both systems which can be easily lost, shared, or stolen.

Fujitsu's answer to the challenge lies in sophisticated biometric authentication – which can be applied to gain access to physical locations such as office buildings, server rooms or even to access personal mail boxes. Devices such as laptops can also deploy biometric authentication. The



authentication is deployed in the easy-to-use form of palm vein readers. Called PalmSecure, this technology that is uniquely offered by Fujitsu, takes advantage of the fact that everybody has a unique pattern of veins in their body which can be used for highly secure authentication. It is hygienic, as no contact is required – users just need to wave their hands in front of the sensor. And of course, vein patterns can't be lost or stolen and are only visible when blood is flowing through them.

## Fujitsu Identity Access as a Service

Users of public systems today have dozens if not hundreds of usernames and passwords that allow them to log-on to countless on-premise systems and cloud services. Fujitsu's identity as a Service is designed to reduce this complexity and to help businesses prevent hacks or fraud, by ensuring that only verified users can access selected systems, applications, data, and resources.

The browser-based service makes it easy to manage, create, adjust, and remove permissions from any connected device or location. It incorporates a variety of strong authentication

methods, including user ID and password, Windows desktop login, single sign-on (SSO), CallSign authentication (based on a phone call and PIN code) and biometric authentication.

As well as the recent growth of ransomware, there are a number of trends that we expect to see in the near future which illustrates the increasing sophistication of cyberattacks:

- Many systems have 'a blind spot' – this lies in the encrypted channels that are designed to give remote workers easier access to networks. If taken over by a cyber-criminal, these channels can essentially provide access to the heart of a critical computing system and mean that nefarious activities are largely undetectable.
- Our state-of-the-art Fujitsu SOC's also expect to see cybercriminals continue to target financial applications. In particular, our experts predict that the SWIFT global payment network will be targeted, in addition to further growth in banking Trojans that are targeting older, more vulnerable back office applications. Although SWIFT is moving to establish mandatory controls, we still think it is a window of opportunity for cybercriminals.

- Smart cities will also find themselves targeted – many of the protocols designed for smart connected devices have their own potential flaws and vulnerabilities. The implications of this are wide-ranging and could include allowing hackers to disable power supplies or other infrastructure services. This would plunge entire cities not only into darkness but into disarray – because it's also likely that phone systems would stop working – and could even impact on water supplies.

## "Did you know?"

Fujitsu uncovered a massive 'hit list' of 385 million email addresses including many from government agencies and banks on a server hosted in Russia as part of its activity tracking a Dridex Trojan. The server was found in 2015, by following a trail of major customers who had fallen victim to hackers. For more information, see [this video](#).

Further information:

[The Fujitsu 2017 Security Predictions report.](#)

[Inside the Security Operations Centre:](#)

**Secure thinking:** When it comes to cyber security there will always be vulnerabilities. How can you be confident that your information is protected?

[Inside the Gates](#) – The Banking Trojan Threat (Dridex Case study).

# FUJITSU

**Phil Skelton**  
**Cyber Security Specialist**  
 Tel: +44 7867 835336  
[philip.skelton@uk.fujitsu.com](mailto:philip.skelton@uk.fujitsu.com)

[www.twitter.com/Fujitsu.com](https://www.twitter.com/Fujitsu.com)  
[www.fujitsu.com/uk/services/infrastructure/security/](https://www.fujitsu.com/uk/services/infrastructure/security/)

# We live in a digital world, but are our children ready for it?

Julia Adamson from BCS, The Chartered Institute for IT explores today's digital world and asks if our children are ready for it

The Autumn 2017 Budget recognised that the UK's future prosperity, growth, productivity, exports and ability to attract inward investment all depend on how the nation responds to the challenges of the digital revolution. Unlike earlier technological revolutions, which created opportunities for low, medium and high skilled workers, those without the skills to enter the new economy will be driven into lower-skilled roles that add to the UK's productivity problems.

Economies will similarly be faced with the choice between actively pursuing the high skill, high-value end of the economic spectrum or drifting into the lower skilled lower value areas. A positive vision for the digital future is welcome, not least because the economy and society are inextricably linked – young people's future opportunities depend on the shape and structure of the economy and digital skills are now essential for active citizenship and all areas of life.

The budget identifies, though not always explicitly, some key roles for government. Firstly, there is a focus on leadership and vision, identifying future opportunities for innovation and growth, such as driverless cars and artificial intelligence. Secondly, there is a focus on creating the conditions in which innovation can flourish by building the right infrastructure and regulatory environment. Thirdly, it recognises that government has a central role in ensuring that everyone has the knowledge and skills needed to participate actively in the digital economy.

As we prepare to make our way in the global digital world as a producer rather than simply a consumer of digital products, an ever-increasing number will need the higher order digital skills to create new ideas, knowledge, products and services. Leaving the EU may affect the UK's ability to recruit abroad, so home-grown

talent will become increasingly important and the only way to address this skills challenge at scale is through the education system.

The importance of higher order digital skills is reflected in the computing curriculum, which goes beyond basic user skills, aiming to equip "pupils to use computational thinking and creativity to understand and change the world." (National Curriculum for England). This is a great aspiration; however, governments and national curriculum documents do not teach students, teachers do.

The computing curriculum will only succeed if enough teachers have the necessary knowledge, skills and confidence. Currently, over 75% of existing teachers do not have an academic background in computer science and recruitment for computing teacher training missed the target for the academic year 2016/7 by the biggest margin of all English Baccalaureate (EBacc) subjects. Without a centrally led intervention to support the training of computing teachers, the introduction of this new subject will stall as evidenced by the slowdown in the growth at GCSE this year.

The DfE has supported the Network of Excellence (NoE) in Computer Science, part of the Computing At School group within BCS. The NoE provides effective continuous professional development (CPD) for teachers who are new to computing, increasing both their confidence and capability, the number of their students taking GCSE Computer Science and their grades. It has made fantastic progress. Since April 2015, it has provided over 80,000 hours of CPD to nearly 8,000 schools.

While these numbers are impressive and exceed the expectations for the programme, they amount to just over 3 hours per teacher. Few French teachers would



be confident to teach Mandarin after 3 hours training. The government has recognised that a step change in the level of support is needed and we welcome government's commitment to upskilling 8,000 existing teachers to become competent computer science teachers.

However, simply 'training' teachers is not enough. Teachers need continuing support if the training they receive is to lead to a change in the classroom. There are many examples of teacher training schemes that have failed because teachers were not provided with the necessary support to implement what they have learned. Evidence shows that this support is best provided through the ongoing support of other teachers via a professional network. The NoE has recruited and supported over 500 Computing at School "Master Teachers. These are skilled classroom professionals working in schools who provide support to others and are themselves supported by university-based regional centres. The recently announced National Centre for Computing will have the crucial role of ensuring that computing teachers can call on the continuing support they will need.

£84 million is a significant government investment. The potential return on that investment in terms of young

people's opportunities and economic growth are enormous, but achieving that return on investment will depend on the enthusiasm of teachers.

It's clear that a lot more is now understood about achieving change at scale and we look forward to the CPD programme and the national centre building on what has been learned to ensure that the announced programme is done for and with teachers, rather than done to them. With proper CPD and the support of an effective professional network, teachers will embrace the new subject, the opportunities it offers for their students and their role in building the future. ■

**Julia Adamson**

**Director of Education**

BCS, The Chartered Institute for IT

Tel: +44 (0)1793 417 417

NOE@bcs.uk

[www.bcs.org](http://www.bcs.org)



# 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

The May deadline for GDPR compliance is rapidly looming into full view, by this time organisations must have established GDPR-compliant policies to ensure that anyone holding personally identifiable data can prove the consent, the security and the 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.



**Andrew Cowling**  
**Channel Marketing Specialist**  
 Fujitsu Scanners  
 Tel: +44 (0)208 5734 444  
[andrew.cowling@uk.fujitsu.com](mailto:andrew.cowling@uk.fujitsu.com)  
[scannersales@uk.fujitsu.com](mailto:scannersales@uk.fujitsu.com)  
[www.emea.fujitsu.com/scanners](http://www.emea.fujitsu.com/scanners)  
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# Why public-sector organisations must ‘Break the Boundaries’ in 2018

Georgina O’Toole, Chief Analyst at TechMarketView, explains why, in an increasingly digital environment, public-sector organisations cannot afford to be insular. 2018 is a year when they must look beyond their organisational boundaries, she argues

TechMarketView’s recently published analysis of the UK public sector ICT market revealed a picture that can be viewed in the context of ‘micro’ trends and ‘macro’ trends.

In our view, the ‘micro’ trends, i.e. the direction that the UK government is taking in terms of its ICT strategy, are largely unchanged. There has been a softening in some areas, for example, a more pragmatic approach to the disaggregation of contracts in central government and a hardening in other areas, for example, a stronger emphasis on the need to deal with complex data issues, and greater concerns around cyber security following the recent ransomware attack impacting the NHS. And these changes in emphasis will, undoubtedly, impact the pace of progression.

But in general, despite ministerial changes following the snap General Election in June 2017, we do not see any strong desire to backtrack on previous commitments. For example, there is still a push to work with more SMEs, to let smaller and shorter contracts, and to implement common technology services where appropriate. And since the middle of 2017, our view is that there has been increasing emphasis on how to best rationalise, manage and utilise data, as well as a desire to ramp up the open data agenda.

Rather, the change has been in the ‘macro’ picture: around budgets (dependent on the chosen approach to reducing national deficit and debt, as well as the Brexit ‘divorce bill’); around resources (impacted by ongoing reductions to the civil service, changes in the treatment of contractors (IR35), contract disaggregation and the desire to upskill internally, and the potential impact of Brexit); and around Brexit itself (the potential brain drain

and the need to resource Brexit-related programmes). These are the 3Bs illustrated in this article. Those ‘macro’ trends are making the market increasingly volatile and challenging to predict across all subsectors.

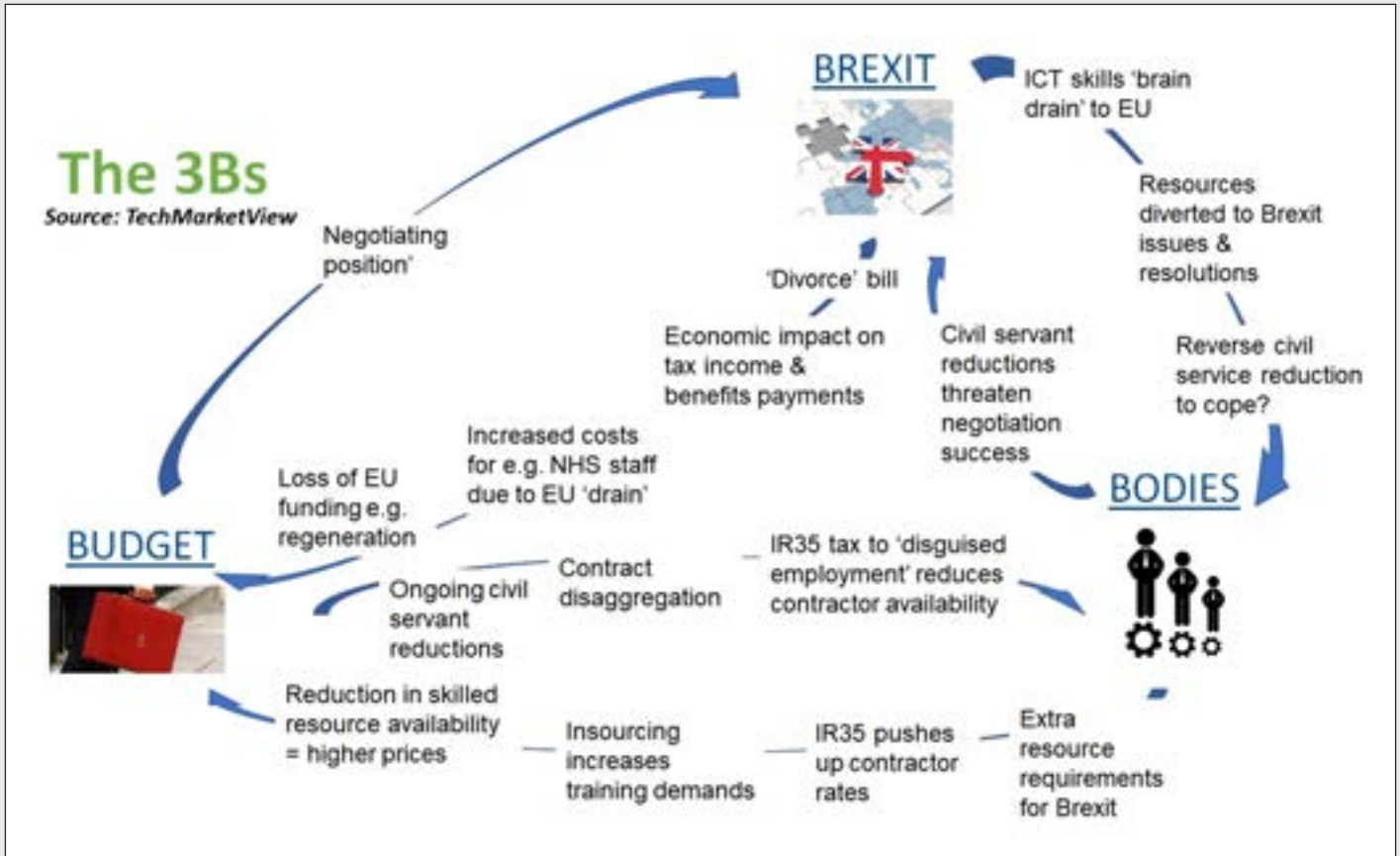
## Balancing short-term digital investment with long-term goals

The combination of ‘micro’ and ‘macro’ trends is creating a push-pull scenario, driven by the need to invest to attain increased efficiency and productivity fighting with the requirement to control budgets in the short-term. This is where the need to accelerate the digital transformation agenda comes in. Digital transformation has risen to the top of the agenda in the public sector. Austerity has been the catalyst, but as the benefits of digital has become better understood, increasing numbers of organisations are taking the journey. They know, though, that they must be able to prove investment now will deliver a return in short-thrift.

## Breaking the boundaries

That is a big challenge in the context of tight budgets, a shortage of skills and resources, and a fear of some of the newest emerging technologies. And it will force organisations to look beyond their four walls when it comes to skills & resources, to data, to technology and to innovation.

**Skills & resources** – Pressures such as Brexit, the challenges of IR35 and a digital skills shortage means the government will need to be creative in sourcing the requisite transformation capabilities. That might mean considering the use of public freelance marketplaces or crowdsourcing to achieve greater flexibility and agility when responding to rapidly changing digital requirements.



**Data** – Organisations are waking up to the value of data – pursuing the open data agenda, creating new data and looking to external sources. Those external sources might be public, but they might also come from forming innovative partnerships with data owners.

**Technology** – As the adoption of as-a-service and 'internet of things' solutions (e.g. for smart cities) grows, organisations must increasingly put their trust in infrastructure and technology beyond the four walls of their internal server room or data centre. New challenges around reliability and security will abound.

**Innovation** – To ensure that their use of technology is advancing at an appropriate pace, innovation can also come from the 'outside'. Drawing on ideas from academia, hackathons, innovation hubs, as well as the traditional supplier network, will necessarily increase.

In many cases, new approaches will mean reconsidering traditional operating models and breaking the boundaries between departments, agencies, regions and partners, whether via closer collaboration, transference of skills, the re-use of technologies or the sharing of data. Even harder, though, will be breaking cultural boundaries, adopting a completely different data-driven mindset to unlock the true potential of digital technologies.

Over the course of 2018, TechMarketView's PublicSectorViews team will continue to publish in-depth supplier and market analysis, as well as shorter viewpoints on the 2018 'Breaking the Boundaries' research theme. The result will be an invaluable mix of research designed to help government organisations and ICT suppliers understand the opportunities and threats represented by the changes in this ever-evolving area. ■

#### References

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- 2 TechMarketView research theme 2018: Breaking the Boundaries (<http://techmarketview.com/news/archive/2017/12/18/breaking-the-boundaries-2018-the-techmarketview-agenda>)
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#### Georgina O'Toole Chief Analyst

TechMarketView LLP

Tel: +44 (0)1252 781 545

[gotoole@techmarketview.com](mailto:gotoole@techmarketview.com)

<http://techmarketview.com/>

[www.twitter.com/TechMarketView](http://www.twitter.com/TechMarketView)



# 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.start 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.start 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.start business accelerator program, which originally targeted tech start-ups, to large corporations as well.

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**"In summary, the main advantage of this corporate imec.start program is that companies can explore potential new business opportunities in a safe and inspiring ecosystem that fosters innovation."**

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## What is imec.start?

The imec.start 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.start 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.start 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.start 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.start 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.start 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.start team is continuously looking for new ways to stimulate innovation. Within this framework, they have recently decided to open up the imec.start 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-creat-

ing 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](mailto:sven.decleyn@imec.be).

**imec**

**Sven De Cleyn**  
**Program Manager imec.istart**  
 imec  
 Tel: +32 474 29 76 94  
[sven.decleyn@imec.be](mailto:sven.decleyn@imec.be)  
[www.imec.be](http://www.imec.be)  
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- Economic prosperity to society as a whole.

The impact such tools have for individuals, their families, and society at large are undeniable. We are able to provide opportunity and dignity to those who deserve it most. Solutions have been created for people to achieve greater autonomy in their daily life.

## T4F providing autonomy to blind people.

But we go much further in the worldwide health-tech sector. With the objective of empowering people with disabilities who can also coexist with health problems that require constant monitoring, such as hypertension, diabetes, or injury risk in the elderly.



Those who say it can't be done are usually interrupted by others doing it.

## Joel A. Barker

T4F's mission is to improve people's lives by better meeting their specific health needs.

In this context, T4F is strengthened as the first vertical integration platform, which is already launching a device for universal use.

T4F has made it possible for technology to be the best ally to achieve a more inclusive society, creating social welfare and economic prosperity for all.

[www.tech4freedom.net](http://www.tech4freedom.net)

Interesting Links:

["Tech4Freedom among the 13 most innovative companies at Mobile World Congress 2017"](#) (Mashable).

["The European Commission invests in Tech4Freedom"](#).

["Tech4Freedom recognized with the Alan Turing award for social commitment 2016"](#).

["Middle East welcomes Tech4Freedom"](#).



# Protective security advice for the UK's national infrastructure

The Centre for the Protection of National Infrastructure (CPNI), the UK government authority for protective security advice to the UK's national infrastructure, is placed under the spotlight by Open Access Government

The Centre for the Protection of National Infrastructure, (CPNI), is the government authority for protective security advice for the UK's national infrastructure. Their primary role is to protect national security through means of helping to reduce the vulnerability of the national infrastructure from terrorism and other threats. As well as obvious areas of critical danger, less urgent but still vulnerable assets and events such as high-profile landmarks or iconic targets are also protected by the CPNI indirectly, through advice and damage protection. The CPNI is impacted by a range of government policies such as the National Security Strategy (NSS), the National Risk Register and the Counter-terrorism strategy (CONTEST).

CONTEST aims to reduce risks of international terrorism, allowing individuals and businesses to continue with ease. This strategy is divided into four principal strands: Prevent, Pursue, Protect and Prepare. The CPNI's work falls within the 'Protect' strand, which is concerned with reducing the vulnerability of the UK and UK interests overseas to a terrorist attack. CPNI's protection work covers facilities, sites, information, people, systems, network and processes under the blanket of "infrastructure". Everything upon which daily life depends on and requires protection due to the potential danger of UK citizens is included in National Infrastructure, yet all is not "critical".

The UK government's official definition of their focal points in this area – the CNI (critical national infrastructure) is: 'Those critical elements of national infrastructure, the loss or compromise of which would result in major detrimental impact on the availability, delivery or integrity of essential services, leading to severe economic or social consequences or to loss of life.'

The CPNI website defines 13 national infrastructure sectors in the UK, which are as follows: Chemicals, civil nuclear communications, defence, emergency services, energy, finance, food, government, health, space, transport and water. Several sectors have defined 'sub-sectors'; emergency services, for example, can be split into police, ambulance, fire services and coast guard.

Naturally, the CPNI works with a variety of partners to both identify risks and reduce the vulnerability of these 13 areas. CNI's are a focal point and as such, key partners include government departments, businesses and organisations with those sectors that own or operate a CNI; and other security specialists, including the police. Government partnerships feature most heavily, as the CNI protection sits under the Cabinet Office, enabling a strategic approach. However, the Home Office has Ministerial responsibility for countering terrorism in the UK. The Office for Security and Counter-Terrorism (OSCT) in the Home Office oversees and manages the government's CONTEST strategy and programme plan.

According to the Home Office, the threat from terrorism is changing and therefore so must the responses. This is one of the primary reasons the Home Office are taking the time to review the already established counter-terrorism strategy and powers and why they have taken certain measures, such as implementing extra resources into counter-terrorism.

Furthermore, work to improve protection in public places continues, which includes increased physical security measures at locations such as bridges and city centres. September 2017 marked Home Secretary, Amber Rudd's announcement of an extra £24 million of funding to be pumped into counter-terrorism policing



in the wake of that year's terror attacks. The new funding will be used to help bolster protective security measures in crowded places. This will include helping to protect the public from the specific threat of vehicles being used as weapons. Despite this, it is evident that it is vital between striking the balance between taking as many precautions as possible, but also making it clear to the public that they should not be afraid to go about their daily lives. Alert, but not alarmed, is the message that the UK government aims to broadcast.

In addition, in July, the UK's Security Minister announced a new fund of up to £2 million, to be made available for new, cutting-edge research to improve both the surveillance and detection of potential threats in crowds. The Home Office also states that all police forces have access to the National Barrier Asset (NBA), which is a central resource of temporary Hostile vehicle mitigation (HVM) barriers, gates and fences that provide protection against vehicle-based attacks, like those seen in Nice, Berlin, Stockholm, London and Barcelona.

This work is produced to build on the UK government's long-standing work programme providing owners and operators of crowded places with high-quality advice and guidance, to understand the terrorist threat and to enable appropriate measures to be taken to reduce their vulnerability to and prepare for a terrorist attack. Specialist advice for companies operating in crowded places, split into different sectors such as major events, sports stadia, visitor attractions, bars, theatres and shopping centres, have also been refreshed.

The UK's Home Secretary Amber Rudd stated: "The threat we face from terrorism is becoming more complex and diverse. That is why we are reviewing our counter-terrorism strategy to ensure the authorities have the powers they need to halt terrorist activity".

As we can see the future marks forward-thinking initiatives and plans from the Home Office, who have proposed that £144 million will be provided over the next five years for a national uplift in UK armed policing capability to respond more quickly and effectively to an attack. This means that the number of armed police will increase by more than 1,000 over the next two years, additional round-the-clock specialist teams are being set up outside London and 41 additional police armed response vehicles will be on our streets.

The first and foremost phase of the armed uplift is complete, with some additional 41-armed response vehicles, as well as around 650-armed officers. The next phase will mark a dramatic increase in counter-terrorism specialist firearms officers and will be expected completion in 2018. Measures are being taken as a response to recent changes in terrorism threats and working with the CPNI, they hope to reduce such threats throughout the UK where the need is. ■

Open Access Government  
[editorial@adjacentopenaccess.org](mailto:editorial@adjacentopenaccess.org)  
[www.adjacentopenaccess.org](http://www.adjacentopenaccess.org)  
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# A new frontline against terrorism

Terrorist organisations are now increasingly focused on using vehicles to kill, maim and cause panic. But rather than erecting concrete barricades in defence, Jaz Vilku, Managing Director of Landscape Protection at Marshalls, argues that urban planners must consider a holistic approach focusing on protection and design to ensure people don't feel a continual threat

Vehicles have become the weapon of choice for terrorists. Stripped down to the bare-bones of an individual with motivation, intent and access to a car, van or lorry, the attacks we've seen across Europe over the last few years have cut the time between planning an attack and execution to a matter of hours.

This new threat is far more difficult to predict and has so far prompted a primitive and unsophisticated response, which has become a blanket reaction across our towns and cities. According to the 2017 EU Terrorism Situation & Trends report, the increase in the number of anti-terror barrier installations around landmarks, key infrastructure and public spaces with high footfall has reflected the sharp rise in vehicle attacks.

But fortifying urban areas in this way can convey mixed signals. Yes, concrete barricades send a clear message that threats are taken seriously, but in doing so they remind the public of the need for protection and creates an environment of fear. In a recent Guardian article, columnist Simon Jenkins noted: "Parts of central London already look cowed and afraid, as ugly barriers go up around tourist sites."

## Reducing the perception of risk

It's clear that such Hostile Vehicle Mitigation (HVM) measures can unnerve the public and feed the feeling of



imminent threat. And while the battle is primarily against terror, addressing this perception should be just as key a priority for those designing and securing cities from terrorist or criminal activity. It's a vicious circle: the higher the perception of risk, the greater threat individuals feel. This applies directly to the presence of visible anti-terror security measures, which have been found to increase levels of suspicion, tension and fear among the public.

It's a reaction that is hardwired into the human brain. Anxiety worsens cognitive functioning as our attention is drawn away from day-to-day life and towards the threatening stimuli that confronts us. In seeking to protect places, the very action of fortifying our town and city centres is increasing the

fear that people feel. This can all too easily translate into action, with falling footfall severely hitting businesses and urban areas.

## Tackling the issue through aesthetic design

Installing protective measures can change the nature of these urban spaces and addressing this presents a new challenge. In her study, *Invisible Security: The Impact of Counter-Terrorism on the Built Environment*, Rachel Briggs writes: "It has been argued that 'security' has become the justification for measures that threaten the core of urban social and political life – from the physical barricading of space to the social barricading of democratic society – that rising levels of security in cities will reduce the public use of public space."



To allay this, urban designers should look to adopt a holistic approach to ensure that protection is integrated in a way that doesn't change how people feel about and use their town and city centres. In essence, using measures that are unobtrusive and can be hidden in plain sight.

It's pleasing to see that these considerations are increasingly forming part of urban security planning. Architects, city planners and security experts are less willing to compromise on aesthetics when it comes to security. According to a recent report we produced with IFSEC Global, 79% of these professionals have seen the number of projects requiring aesthetically focused perimeter protection increase over the last three years. In addition, 94% believe that demand will ramp up across both the UK and EU.

## Deter, deflect and defend

One option is a multi-layered strategy that is designed to reduce the threat long before a vehicle can reach its target, while in keeping with an environment's aesthetics. As a first step, designers could look at limiting the speed or mitigate the angle of approaching traffic. This could include changes to the layout of the road network, the addition of traffic calming features, such as chicanes, speed bumps, restricted-width lanes, and the creation of pedestrianised areas and 'buffer zones', which demarcate traffic from pedestrian areas. Secondly, new kerbing systems can be installed to deflect oncoming vehicles back on the carriageway and away from vulnerable areas.

Rather than using concrete blocks or metal barriers as a defensive line to implement a high level of HVM, architects should consider reinforced landscape furniture such as planters,



Image: © 2016 Sarel Jansen

seating, litter bins, lighting columns, cycle stands and bollards. Although these products look like regular landscape furniture, they are built with fortified PAS 68/IWA 14.1 certified cores. This is the latest Publicly Available Specification for products used to assist in terrorism prevention, which specify a classification for vehicle security barriers and their foundations when subjected to impact. The foundations can be built to varying depths and using the strongest specification, a single piece of furniture can stop a 7.5-tonne articulated lorry travelling at 50mph.

From shopping centres and sports stadia to rail stations, leisure venues and our high streets, any space where people gather is now considered to be at risk. But protecting those spaces is a complex balance between making people feel safe and like they're not living in a controlled, militarised envi-

ronment. Given the potential social and commercial impacts that metal barriers and concrete barricades can have, it's vital that future risk assessments on infrastructure and public spaces focus on aesthetics, keeping protective measures out of sight and out of mind.



**Abigail Kellett**

**Product Manager**

Marshalls PLC

Tel: 01422 312000

[Abigail.kellett@marshalls.co.uk](mailto:Abigail.kellett@marshalls.co.uk)

[www.marshalls.co.uk/landscapeprotection](http://www.marshalls.co.uk/landscapeprotection)



# Keeping pace with today's rapidly changing labour market

Marianne Thyssen, Commissioner for Employment, Social Affairs, Skills and Labour Mobility offers her thoughts on today's rapidly changing labour market

To succeed in today's rapidly changing labour market, you need skills. And "static" skills will not be enough. Your skills have to evolve along with changes in the world of work, to keep pace with digitisation and technological change. Lifelong learning is the best way to keep up with these challenges – through education and training at all stages of life. That's why I launched in 2016 a European Skills Agenda which focuses on actions to support skills development.

Training offers across the EU are huge – but too often workers and young people do not know about them. And offers are not always well adapted to a person's individual upskilling needs or to the needs of the labour market.

People often see vocational education and training as the poor relation of university studies. This perception could not be further from the truth.

In the EU, young VET graduates find jobs more quickly than their peers from general-academic education streams. This is a clear advantage when many young people are still struggling to find jobs. Vocational education and training also allow people to upskill and reskill throughout their careers, supporting their lifelong employability. That is why I have made it my mission to show that vocational education and training leads to exciting and rewarding careers – from movie makers to fashion designers, from pilots to medical assistants.

I want to show that vocational education is not a second choice, but an attractive education and career prospect and the European Vocational Skills Week is a great opportunity to do that. The second edition of the Vocational Skills Week ran with great success from 20-24 November 2017, giving a variety of VET providers, employers, youth organisations, EU agencies, national

and regional authorities an opportunity to showcase the best of VET in Europe. In total, more than 1500 events were organised in more than 45 countries across Europe.

We are doing more to make VET a true first choice. We know that millions of learners have benefitted from Erasmus. With the new ErasmusPro action that I launched, vocational students will now have the opportunity to spend a longer period of time abroad to learn new skills, languages and cultures, stepping up the quality and impact of their experience abroad.

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**"Europe is all about cooperation. Together we can tackle the challenges and reap the fruits of the changing world of work. To help people get jobs and engage actively in society, to allow business to compete, the economy to grow and society to flourish."**

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Learners need skills to get jobs. Businesses depend on their skills to succeed. Already today, we need to know the skills of tomorrow – most urgently for innovative sectors including additive manufacturing, green technology and renewables, or cyber security. And for radically changing sectors, such as the automotive industry. This is why we've launched a "Blueprint for Sectoral Cooperation on Skills". Industry-led partnerships will map skills needs and trends in their sector.

Employers, employees and training institutions will work on new curricula to address skills gaps. I am bringing together public authorities, businesses and civil society actors who do not typically work together. We have kicked-off cooperation with twelve industries, ranging from car manufacturing to maritime shipping and from construction to tourism, to name but a few. We hope to expand this in the future.



And the European Skills Agenda is also addressing the gaps we face in digital skills, in particular through the Digital Skills and Jobs Coalition. It reaches out beyond the ICT sector to improve the digital skills of people across the whole economy.

**“Learners need skills to get jobs. Businesses depend on their skills to succeed. Already today, we need to know the skills of tomorrow – most urgently for innovative sectors including additive manufacturing, green technology and renewables, or cyber security.”**

Europe is all about cooperation. Together we can tackle the challenges and reap the fruits of the changing world of work. To help people get jobs and engage actively in society, to allow business to compete, the economy to grow and society to flourish. This is also reflected in the European Pillar of Social Rights which was proclaimed at the social summit in Sweden last month by all EU leaders and European institutions. It’s no coincidence

that the first principle is dedicated to education, training and lifelong learning. The Commission is working hard to make sure that European cooperation on skills continues to be a success story. ■

**Marianne Thyssen**  
**Commissioner for Employment, Social Affairs,**  
**Skills and Labour Mobility**

European Commission

[cab-thyssen@ec.europa.eu](mailto:cab-thyssen@ec.europa.eu)

[https://ec.europa.eu/commission/commissioners/2014-2019/thyssen\\_en](https://ec.europa.eu/commission/commissioners/2014-2019/thyssen_en)

[www.twitter.com/mariannethyssen](https://www.twitter.com/mariannethyssen)

# Improving job search through better information: A low-cost approach

This article by Philipp Kircher at the European University Institute and University of Edinburgh, outlines how the internet can be used to provide information to jobs seekers in a way that changes how they seek work

Getting unemployed people into work is a major policy concern. Among the multiple ways in which one might want to achieve this, the provision of better information about how to look for jobs has undergone a technological revolution. It is time to revisit how we use this channel to help job seekers to find jobs.

Undoubtedly, there are other means by which to improve the situation of unemployed people. Ideally one would like to increase the availability of jobs. That turns out to be extremely hard to achieve. Therefore, policy attention has been directed towards the search behaviour of the unemployed with an aim to fill the existing vacancies more quickly.

Three pillars underlie this:

- (1) Skills of job seekers might not be commensurate to the requirement of the available jobs, so retraining becomes a popular though costly policy;
- (2) Job seekers might not search enough, so monitoring their search behaviour and imposing sanctions is another policy option, and;
- (3) Job seekers might lack knowledge which jobs to search for, so professional advice could allow them to succeed more quickly.

Of these, the first 2 have gained substantial research and public policy scrutiny. One might argue that the third received much less. Here we outline why it is a good time to change this and highlight recent research that aims to effectively provide advice online at low cost.

Providing advice is an attractive policy option because it is a “friendly” option. Job seekers can choose to adopt it if they deem it helpful. This contrasts with the more intrusive measures (1) and (2) above that usually are imposed on unemployment benefit recipients. Providing advice is already part of the tool-kit of most unemployment agencies and most studies show some effectiveness.

One drawback is that employing professional advisors has substantial costs, usually ranging from many hundred to several thousand Euros per individual. Finding positive effects that exceed the costs of the intervention has proven to be difficult. New technologies provide an alternative – the internet is revolutionary precisely in providing information at low cost, especially if this is designed well.

## Which information would be useful?

Recent research documents the co-existence of occupations where many people search for jobs, but few jobs are offered and occupations with the

opposite. More importantly, this occurrence has increased substantially since the last recession. One contributor could be that job seekers simply do not know which occupations are currently attractive and whether their skills might be sufficient to secure a job there. A natural implication is to provide them with this type of information. Such information must be easy enough that people can understand and use it and cheap enough, that it does not stretch the already strained public finances.

In a recent research project on “Providing Advice to Job Seekers at Low Cost: An Experimental Study on On-Line Advice” by Michele Belot, Philipp Kircher and Paul Mueller (CEPR working paper DP109967), we attempt exactly that. We design an Internet platform that incorporates relevant information right into the job search process. We ask individuals which occupation they are looking for. We then show them the most popular occupations that those who are already working there choose subsequently. Given that those other workers were able to make an occupational move, it indicates that skills might be transferable and jobs in these new occupations are available.

We also show occupations that are close in the skill spectrum (without concern for how many jobs there are) and provide maps that illustrate how



“tight” the market is. All this is intended to allow individuals an informed choice about alternative occupations. They can choose which ones they retain and if they then hit the “search” button they obtain actual jobs not only in their originally desired occupation but also in all the related ones.

We trialled this with 300 job seekers in Edinburgh. They were asked to search for real jobs that we were kindly allowed to download from Universal Jobmatch and that cover over 90% of the official vacancy count. All job seekers started with a standard interface where individuals can search by keywords or drop-down occupational menu, with the obvious limitation that they themselves must come up with the relevant keywords or occupations. After three weeks we introduce half of them to the new interface that makes recommendations, though they retain the option to continue as before. We analysed how their job search behaviour and success changes relative to the group that continues with the standard search interface.

We find that the advice leads job seekers to consider jobs from a more diverse set of occupations and increases job interviews. We find this robust especially for those who searched over a narrow set of occupations in the first 3 weeks (prior to our intervention) and who were somewhat longer unemployed (above 80 days). The increase in interviews is substantial: of the order of 40% and higher.

This is not without caveats which need to be resolved in larger studies: amongst them, we have no evidence that they obtain more jobs (but can also not rule out that job finding goes up less than the number of interviews). We aim to resolve this in a larger study within the MacCaLM project at the University of Edinburgh. We also cannot rule out that additional interviews come at the cost of reduced interviews for others who are not in the study.

While we clearly need more evidence, the improvements in interviews suggest a promising outlook – the

costs of providing such information to each additional job seeker are minimal and versions of such an intervention could be rolled out at large scale without tying up large amounts of public money. If it turns out to particularly benefit certain individuals such as narrow searchers with longer unemployment duration, it could be targeted to them directly by the job search website. Given that many governments have public job search websites, this suggests a promising and low-cost avenue to improve the labour market.



THE UNIVERSITY  
of EDINBURGH

**Philipp Kircher**  
**Professor of Economics**

European University Institute and  
University of Edinburgh

Tel: +39 055 4685 42

[philipp.kircher@eui.eu](mailto:philipp.kircher@eui.eu)

<http://homepages.econ.ed.ac.uk/~pkircher/>



# Developing local labour market strategies

Cllr Simon Henig, County Councils Network spokesman for Industrial Strategy & Growth and leader of Durham County Council offers his views on developing local labour market strategies

**L**ocalis' recent report, 'In Place of Work', paints a challenging picture for growth in England's county areas. It identifies three main issues that, Localis argues, threaten national prosperity – Brexit, automation and a shrinking skills base. Further to this, the analysis also revealed that rural county areas account for nine-out-of-10 locations most at risk from these 'threats'.

Importantly, the project showed that while automation may have a small impact in Gloucestershire, it is a real issue in County Durham, where one in ten local jobs are in manufacturing – the fastest growing automation industry. A blanket approach to dealing with these problems will not suffice; instead, Localis argue the importance of 'place' rather than centralism, with solutions tailored to each area's specific strengths and weaknesses.

At the same time, getting a grip of fluctuating workforces and future technological advances are paramount. In some areas, one in ten jobs are in manufacturing – the industry that is seeing the most significant automation. We need to tackle these challenges now and ensure that people have the skills to do the jobs of tomorrow, regardless of age.

The report makes a persuasive case for strategic authorities to ensure that local areas have the ability to deal with these issues head-on and develop local labour market strategies. In county areas, these 'strategic authorities' should be led by the county authority; with a major focus on 'place' rather than centrism.

The County Councils Network (CCN) advocates this approach and many of the foundations of these strategies are already in place in our counties. Counties know their economies intimately and are embedded within them; they have the scale and expertise to bring

together and influence local education providers and businesses in both the public and private sectors and to engineer real change for local people.

In this sense, counties are already delivering. My own county of Durham is carrying forward a 'Durham Works' programme which has engaged over 3500 eligible participants, two-thirds of whom have progressed to employment, education or training.

Elsewhere, Suffolk's 'Raising the Bar' strategy is targeted at increasing local skill levels and in Kent, the county council's apprenticeship website acts as a one-stop shop for apprentices and employers alike.

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**"Localis' recent report, 'In Place of Work', paints a challenging picture for growth in England's county areas. It identifies three main issues that, Localis argues, threaten national prosperity – Brexit, automation and a shrinking skills base. Further to this, the analysis also revealed that rural county areas account for nine-out-of-10 locations most at risk from these 'threats'."**

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But while initiatives such as these are producing good results, empowered counties could do so much more. Building on existing strong relationships, this report argues for further powers to be devolved to strategic authorities; to better match skills with demand, to shape the new apprenticeship levy, to convene employer guilds and to take control of local adult education budgets.

The government's Industrial Strategy, published just a few weeks after this report, made some headway on these agendas – proposing to devolve adult education budgets to the six mayoral combined authorities and recommending that Local Enterprise Partnerships (LEPs) lead local industrial strategies.



From a county perspective, whilst these proposals are imperfect they are workable and importantly, display an important change of emphasis away from the centrism of the initial strategy, published in January, to a more local approach.

Whilst CCN has argued that county authorities, as strategic authorities, should be leading these local industrial strategies, as they contain both accountability and a deep knowledge of their local economies, many counties work well with their LEPs and a strengthened, joined-up approach between the county council and business could reap rewards.

Importantly, the UK government has also committed to reforming LEPs' remit, accountability and geographies. Many LEPs overlap county boundaries; it makes sense from both a business and community point of view to re-align these as close as possible to county boundaries, which are instantly recognisable to all and are shared with many other public services.

The UK government should also consider devolving local adult education budgets to counties; it is unfair that the six metro mayors will receive the benefits of

this approach when a large proportion of the county (over 60%) will not have this benefit. The argument becomes more pertinent when you consider that county areas are the ones who are projected to be most adversely affected by automation and skills shortages – the very things devolved adult education powers could influence.

If we are to truly grasp the nettle locally and ensure we can deal with the issues that imperil the country's future growth, a skills renaissance is needed. Counties must be at the heart of this – either as strategic authorities or through a strengthened role working alongside the business community. ■

**Cllr Simon Henig**

**Spokesman for industrial strategy & growth**

County Councils Network

Leader of Durham County Council

[www.countycouncilsnetwork.org.uk](http://www.countycouncilsnetwork.org.uk)

[www.twitter.com/CCNOffice](https://twitter.com/CCNOffice)



# How technology can be used to deliver public services

Bob Hallewell from Expert Messaging explains why there is a major gap in the UK government's strategy concerning technology to deliver public services

**U**nless you have the right approach, your technology will control your people – rather than your people controlling and benefitting from your technology.

The UK government has set a clear direction – for the public sector to deliver great services they need to take on board the latest technologies. They want to cut waste, and not only improve the delivery of those services but also make substantial savings.

What they have not addressed is the human side: how people are actually going to use the technology. At Expert Messaging, we think this is the starting point.

Unless the human side of using technology is addressed, bad behaviours generate waste and actually get in the way of delivering top-class public services.

Expert Messaging's research into the use of email shows that most people:

- Waste significant time;
- Have excessive volumes of traffic;
- Have seriously compulsive behaviours and;
- Feel the problem is getting worse.

The answer to this growing problem is not to throw more technology at people, but to encourage them to use it in ways that are appropriate, respectful

29%

Cut time spent on email by 29%

32%

Lose 32% of unnecessary CCs

83%

83% are having more conversations

- Typically, managers save 49 minutes every day (giving them an extra month every year).

**“Most useful, focused session I have attended in a long time. Time-saving sensible advice which can be implemented bit by bit or in one big go.” Delegate quote**

Expert Messaging has worked with a huge range of organisations across the public, voluntary and private sectors, transforming the lives of tens of thousands of people.

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### **Case Study: City Council gains £222,600 in 3 x 60 minutes**

A City Council in Scotland was suffering the typical problems with email faced by most local authorities today: 40% of emails received were “unhelpful”; inboxes were overflowing; most staff felt stressed or controlled by email; huge amounts of time were being wasted on email each day.

They decided to pilot three of Expert Messaging’s 60-minute masterclasses. A total of 84 staff attended.

Now, most people are talking more instead of emailing; over half are less stressed by email; unnecessary CC’s are down by one third and people spend an average 30% less time on email.

That time saving across the group adds up to a staggering £222,600 every year. Across the whole council that would come to over £13 million.

Please get in touch if you would like the whole case study.

**“This one-hour workshop has transformed the way I work – I’m now far less stressed about email and much more productive. It has made a huge difference and the more people who do the training, the easier life will get for all of us.” Delegate quote**

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messaging

**Bob Hallewell**

**Managing Director**

Expert Messaging

Tel: +44 (0)20 7633 0050

[b.hallewell@expert-messaging.com](mailto:b.hallewell@expert-messaging.com)

[www.expert-messaging.com](http://www.expert-messaging.com)

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- People spend 29% less time on email;
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- 64% feel less stressed;
- 78% find themselves having more conversations than before and;





# How can we reverse the teacher recruitment and retention crisis?

Emma Hollis, Executive Director of the National Association of School-Based Teacher Trainers (NASBTT) sheds light on the issues around teacher recruitment and retention

**W**ith issues around teacher recruitment and retention going way beyond discussions in staff rooms and school corridors and into the public eye, those of us at the heart of teacher training are being increasingly consulted by politicians, policy-makers and civil servants on how this ongoing crisis can possibly be addressed.

Figures published by the Department for Education last summer showed that teacher vacancies have risen sharply by 26% in the past year, with 920 vacancies for full-time permanent teachers in state-funded schools, up from 730 the year before. The nub of the challenge is how can we ensure that we have a sustained and quality, teacher workforce that meets the needs of schools and our children? Sounds simple, but unfortunately it isn't. Plummeting morale, pay and budgetary restraints, stress and challenging working conditions

are all having an impact on teachers; many are being driven out of the profession and fewer are choosing to enter it in the first place.

So, what can be done? Our members, primarily School Centred Initial Teacher Training (SCITT) providers, School Direct Lead Schools and Teaching Schools, are critical to making sure we have those teachers available and supporting excellent provision. In the 2017 Good Teacher Training Guide, 8 of the top 10 providers of Initial Teacher Training (ITT) in the country are SCITTs and we must build on that success.

Latest figures also show that more than half of post-graduate trainees take school-led routes into the profession. A higher proportion of final-year trainees on school-led routes achieved Qualified Teacher Status (QTS), 93%, compared with 90% on university-led

**Emma Hollis**  
**Executive Director**



In year 2, during the NQT year, time would be set aside for academic study with a focus on reflection. At this point, they have some 'practice' to reflect on and can assimilate the theory behind many of the practical techniques they will already be aware of. NQTs would be exposed to ways of thinking that might differ from those they have been exposed to in school and will widen perspectives from a place of practical knowledge.

In year 3, teachers will have a sense of what interests them, what type of teacher they are or would like to become. They would use this year to focus on a research area which either meets their personal interests or a need within their school. Funded time would be given to write a dissertation exploring this area of interest, this could contribute towards Master's qualification or Chartered Teacher Status and thus feed back into the system research carried out by a practising teacher based on real-life examples which support their hypotheses.

Yet there is a bigger picture – and this is what we now need from the UK government. Firstly, a recognition that access to high-quality professional development for teaching staff, both in their early careers and throughout their working lives, should be an entitlement and not a lottery based on whether the school in which they happen to work values professional development. Secondly, sufficient funding for schools to allow their staff the time they need to develop their knowledge and skills and become well-rounded, highly educated and respected professionals. Thirdly, support for the Chartered College of Teaching which is seeking to develop a Chartered Status for the profession and which needs the continued support of the government. Finally, a commitment to allowing sufficient lead-in time for policy changes to avoid uncertainty and confusion within the system. ■

**Emma Hollis**  
**Executive Director**

National Association of School-Based Teacher Trainers (NASBTT)  
Tel: +44 (0)1933 627 049  
[office@nasbtt.org.uk](mailto:office@nasbtt.org.uk)  
[www.nasbtt.org.uk](http://www.nasbtt.org.uk)  
<https://twitter.com/nasbtt>

routes. They were also more likely to get a job than their university-trained peers, with 96% of those awarded QTS in a teaching post within 6 months.

However, whilst teacher training is routinely presented as an 'either/or' choice between school-led and university-led provision, these artificial and unhelpful distinctions between different kinds of training provision should be forgotten. The reality is SCITTs, universities, Teach First and School Direct providers have long worked together.

We are supportive of a simplification of the teacher training system and continue to encourage greater partnership working. Any plans for strengthened QTS, for example, should include scope for collaboration between schools, SCITTs and universities in planning and delivering the early career professional development to build on the excellent foundations being achieved. So, what might this look like in practice?

Our vision is for a revised 3-year postgraduate teacher training route. In year 1, we would have school-based practice focusing on pedagogy and relationship building to help teacher trainees become ready to 'hit the ground running' in their Newly Qualified Teacher (NQT) year. We would look at the realities of the classroom, practical advice on class management, curriculum planning, time management, marking and feedback and subject knowledge for teaching. As is now the case, QTS would be awarded at the end of this year.

# Essex County Council – creating a golden thread of support for children and families

Emma Toublic, head of education information and business systems at Essex County Council explains how the secure sharing of key information can make a difference to the support received by children and families

When key information can be shared securely and efficiently between teams working with children and families, it can make a real difference to the timing and impact of the support they receive.

For multi-agency teams providing support for children and families, it is mission critical to be able to record and share key information securely and simply to get them the help they need.

But if the information practitioners need to do their jobs is held in a variety of databases, spreadsheets and paper files, this can create an unnecessary obstacle when it comes to ensuring the right help is put in place, at the right time to make a difference.

In Essex County Council, we are doing things differently. We have embarked on an initiative to bring over 700 disparate data sources together, enabling our education support teams to see the completed jigsaw of a child's life in one place. And we are already seeing the benefits of taking this approach.

## Uncovering the issues

If a child suddenly stops coming to school, their caseworker needs to be able to quickly understand what issues might be behind this to help get them back into the classroom.

With the right information to hand, the caseworker could discover that the child has a history of poor attendance or exclusion, or that there has been an ongoing concern with their behaviour in the playground over the last two weeks.

They might find details of a problem at home that the child is struggling to cope with or that their family is



**Emma Toublic,**  
**Head of education**  
**information and business**  
**systems at Essex County**  
**Council**

receiving some additional support from the council. Knowing this could have an impact on the decisions made around what action needs to be taken to re-engage the child in education and prevent them from falling behind in their learning.

## Pulling together the strands

Bringing data from different places together can be transformational to the way local authorities work, as we have found. It means that authorised staff can access the information they need from the authority's computer system – ours is Capita's One management information system – in a few clicks.

By creating this single view for every child, we have brought together records from early years, through school and youth services. The aim is for information on a child to be stored securely and centrally, from birth into adulthood, so teams with the appropriate permissions can see at a glance how many times the family has moved to a new house, whether the child receives free school meals, and even if there is a dangerous dog at the address. This helps us to ensure children and families get the help they need.



### Forward planning

With data held centrally, the authority can also forecast for what help children and families might need in the future too.

If we receive details from a children's centre that a toddler with a disability has just been registered, for example, we can ensure the relevant team is equipped to provide support to the child's family. We can also plan our budgets for the additional provision that will be required when the time comes for them to start school.

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**“In Essex County Council, we are doing things differently. We have embarked on an initiative to bring over 700 disparate data sources together, enabling our education support teams to see the completed jigsaw of a child's life in one place. And we are already seeing the benefits of taking this approach.”**

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Looking at the longer-term picture, we can prepare for the child's transition to secondary school and into work, by forecasting transport services and any support they might need to live independently, wherever this is appropriate. This is set to transform the way we work with children and families now and in the years ahead.

### Efficiency drive

This initiative has had a major impact on our internal processes too. Previously, when we arranged a meeting

to discuss a child or family's circumstances, up to 10 different people would need to come in and sit around the table, each bringing their notes and files. Now, the relevant practitioners can record and view information on the families they are supporting on a single device, so everyone involved is kept in the loop.

In addition to this, our data is stored securely in the cloud, so staff no longer spend time managing routine systems maintenance tasks or carrying out software upgrades.

By bringing together different pieces of data on children and families, our teams can join the dots and see the bigger picture of their lives. This is essential for providing us with a golden thread of information that will help us to plan and deliver support, where it is needed, to improve outcomes for the people of Essex. ■

### Emma Toublic

#### Head of education information and business systems

Essex County Council

Tel: +44 (0)345 743 0430

[contact@essex.gov.uk](mailto:contact@essex.gov.uk)

[www.essex.gov.uk/Pages/Default.aspx](http://www.essex.gov.uk/Pages/Default.aspx)

[www.twitter.com/essex\\_cc](https://twitter.com/essex_cc)



# Reinforcing the foundations in Canadian teacher education

Both the Canadian Association of Foundations of Education and Canadian History of Education Association examine the fundamentals of teacher education in the country today

The foundations of education, usually including the fields of educational history, philosophy and sociology, have held a central place in most teacher education programmes in Canadian universities. Traditionally, these subjects were taught as a means for teacher candidates to understand their place within their profession and the larger society.

Over the past two generations, the foundations have gone through profound changes in perspective that reflect the cultural, legal and philosophical shifts of this country's populace: based on its roots in the humanities, the foundations' content, methodology and pedagogy now offer vital, critical perceptions and approaches to understanding and teaching in our pluralistic globally-oriented society.

In the most recent wave of educational reform discussions, however, arguments have been made that treating foundational fields as isolated disciplines is an outdated approach, ineffective in a post-modern, integrated world. This assault has taken on two facets that have become all too common: the desire to eliminate the "foundations" configuration altogether in teacher education to be replaced with more 'practical' study; or, the appropriation of the term "foundations" by fields not heretofore associated with this area of study.

## **Prioritising educational research and teaching**

As Faculties of Education reassess and redistribute their programme content, a host of more practical subjects (e.g., educational technology, classroom management and instructional methodologies) have tended to take expanding roles in the newest courses of study, while educational foundations fight rear guard actions, arguing only for its preservation in some form. In more stark cases, such as the recent decision at the Ontario Institute of Studies in Education, whole Departments

related to the foundations have been shuttered, with researchers being redeployed into other areas.

Of course, this does not represent the path of all scholarship and university programmes across the country. Nevertheless, we are very concerned that the undermining of the foundations will have a grave effect on the possibility of improving educational understanding in our country. We argue that teacher education must be more than merely training for classroom practice – the offering of tips and tricks. Rather than separating the theoretical from the practical, choices of practice must be underpinned by critical and creative thinking arising from holistic understandings. The study of classroom management, for example, can only be properly understood when revealed through a wider philosophical, historical and sociological framework. Here, students may be able to balance promising practices with such larger issues of power, context and anti-racist/anti-oppressive education.

## **Arrogation**

Other stakeholder groups within the debate concerning teacher education argue that research and teaching in the foundational areas need to be expanded to include additional fields such as anthropology, Indigenous studies and gender and sexual diversity studies and that these studies be taken up in integrated ways. As such, a number of new courses not traditionally associated with the foundations have appeared in various programmes, as well as on government research grants.

Overall, this is part of the ongoing debate within any discipline. What we argue, however, is that the foundations should not be viewed as a simple body of knowledge to be memorised, with more content being added in a snowball effect. Rather, the field must come together as an integrated perspective that can aid both



teachers and citizens as they confront the plethora of complex questions and concerns they will face in the 21st century. Splintering the foundations into a loosely connected umbrella of courses would not help achieve the needed deeper understandings.

### Challenges that lie ahead

While recent attempts to dislodge the “foundations” have shaken confidence, we posit that the single greatest challenge to improving education in Canada arises out of the taken-for-granted assumptions of technorationalism and neo-liberalism. If Canadian educators and educational researchers focus on the logic of ‘efficiency and effectiveness’, simply preparing individuals for the ‘world of work’, then how can we expect teachers and citizens at large to take up and engage in holistic and more profound ways of thinking?

We believe that teaching and research in educational foundations should take on greater significance as success in society will depend on knowledge and learning about the historical context of educational/societal assumptions, theories and practices; about how knowledge is put together and ethical decisions made; about school systems as social structures embedded in communities; and about the disparities that existed and

continue to exist in society and schools, including those based on race, ethnicity, class, gender, abled-ness and so on.

This means, of course, that the foundations must be more than museum-work. Like any other living entity, it must grow and adapt to the changing world around it. This involves breaking the old rigid disciplines into more integrated, flexible shapes, more accepting of new ideas and forms. If educational foundations can grow, adapt and integrate, this area of teaching and research will contribute in deep and meaningful ways to improving education in Canada. As such, bolstering foundational studies is an important part of the way ahead in bettering education in Canada. ■

**Kurt Clausen**

**President, Canadian Association of Foundations of Education**

[cafe.acefe@gmail.com](mailto:cafe.acefe@gmail.com)

[www.cafe-acefe.com](http://www.cafe-acefe.com)

**Lynn Lemisko**

**Past-President, Canadian History of Education Association**

[www.ache-chea.ca](http://www.ache-chea.ca)

[www.twitter.com/chea\\_ache](https://twitter.com/chea_ache)

# Non-Indigenous individuals' responsibilities within higher education contexts

Dawn Zinga, from the Department of Child and Youth Studies at Brock University explore the responsibilities of non-Indigenous individuals within higher education settings and the inequalities that exist

As a non-Indigenous scholar working in the area of Indigenous education, I spend a lot of my time thinking about my own role in perpetuating inequality within higher education and answering questions posed by non-Indigenous faculty, staff, and students. These questions usually fall into two broad categories. The first category consists of questions about why I am raising an issue or why something is important, while the second category tends to focus on questions about what individuals can do now, so that they know about the inequities that exist. These two categories of questions point to some interesting aspects about the responsibilities of non-Indigenous individuals' within higher education settings. One of the first responsibilities is to become educated about the realities of Indigenous peoples and related the systems of inequality. The second responsibility that I will focus on is what to do with the knowledge that you gain when you become educated.

Starting with myself, I am a several-generations-removed immigrant to the ancestral lands on which I reside and I have experienced a position of some privilege in the mainstream structures of society, such as education, health services, and other governmental systems. While I grew up in a blue-collar home and experienced



the discrimination that can be associated with class and being a girl, I was afforded many privileges and rarely had cause to question that I belonged in the classrooms that I occupied. I frequently saw myself and my life experiences reflected in the classroom and my experiences within society. From a young age, I had a questioning mind and often challenged teachers about why some voices and some life experiences were not represented in the curriculum or were represented in very narrow and proscribed ways. Through my own search for knowledge and the generous teachings of my Indigenous colleagues, I became aware of the systems of racism and inequity experienced by individuals who are

minoritised by the mainstream systems of privilege and discrimination that continue to be reinforced throughout society and particularly within systems of education. In my role as a university professor, I am also responsible for exposing undergraduate and graduate students to these systems of inequity and to challenge their taken-for-granted assumptions.

Some of my students resist any challenges to their understanding of society and the status quo and remain facing the first responsibility of education. Other students engage in the teaching but sink into guilt and seem paralysed by the immensity and





complexity of the issues they have just learned exist. The second responsibility of what to do with the knowledge once you have learned it is easier to address than the resistance to learning that the world does not necessarily operate in a way that you thought that it did, and that with or without your knowledge, you have occupied a position of power and privilege. The first thing for non-Indigenous individuals to realise is that guilt is an emotion that will not be helpful. It must be experienced but in the end we are not responsible for the actions of those who preceded us, but we are responsible for how we address the legacy

that was left behind. Essentially, non-Indigenous individuals must focus on how to act on the knowledge that has been gained.

Non-Indigenous individuals have a choice. They can choose to close their eyes to uncomfortable realities and continue on perpetuating them or they can choose to use their individual voices to make a difference. Using one's voice can be as simple as speaking up when an inequality is being perpetuated, or challenging a policy that negates other people's experiences or lived realities. It can be exposing others to knowledge they

may not be aware of or supporting someone when that person's viewpoint is being shut down as invalid or irrelevant. Sometimes it can be listening to another perspective and being open to being challenged and educated about how your own actions or lack of action may have reinforced inequalities or alienated Indigenous individuals.

Addressing these two responsibilities within educational contexts can lead to educational settings in which Indigenous students and other Indigenous individuals feel welcome and accepted. It can open up important spaces to talk about ways of moving forward together towards positive change that does not reproduce or perpetuate systems of inequality. While I have focused on higher education contexts, this can also be extended to other educational contexts. Making a choice to address these responsibilities daily is a choice to move beyond resistance and guilt to positive action and strong relationships that can help us all negotiate a new future of education for all students.

**Brock**  
University

**Dawn Zinga**

**Associate Professor and Chair**

Department of Child and Youth Studies

Brock University

Tel: +1 905 688 5550 ext. 3152

[dzinga@brocku.ca](mailto:dzinga@brocku.ca)

<https://brocku.ca/social-sciences/departments-and-centres/child-and-youth-studies>



# Speech, language and communication skills

Director of Education at I CAN, Deirdre Fitzpatrick turns the spotlight on speech, language and communication skills (SLCN)

**A**s I CAN's Director of Education I'm proud to be able to say our schools, Dawn House School in Nottinghamshire and Meath School in Surrey, provide an environment where all children and young people are valued and motivated to meet high standards. Finding out what's motivating for a child is key; after all, everyone is motivated by something. Of course, education is about more than the national curriculum, it's about providing the opportunity to develop independence, enhance communication skills and support the crucial social skills needed in all aspects of life.

For the 1.4 million children and young people in the UK with speech, language and communication skills (SLCN), these things can be a challenge; therefore, providing the opportunities to learn these crucial skills, in a way that suits each individual student, is a core part of successful support.

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**“Every child with SLCN is different; they will have their own strengths and needs even if they have an official diagnosis. We continue to strive to help everyone recognise their potential and support them to flourish.”**

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Recognising the benefit of this individualised approach, building on a child or young person's strengths, provides the opportunity for schools and settings to create a truly inclusive society for children with special educational needs (SEN) through their thinking and approach.

A few years ago, I read Steve Silberman's book, *Neurotribes*. At the time I was head of a school which had a large cohort of autistic young people. The book clarified my thinking on autism and perceived disability: autistic young people think differently and therefore enrich our society.

I began to realise that as well as supporting those who think differently, we should be celebrating the diversity of thought, encourage young people who think differently to flourish and utilise the skills they have to offer. We shouldn't simply be educating them to fit into our world but educating society to understand and appreciate the unique strengths of those who think differently. Consequently, society needs to develop, adapt and grow, utilising diversity of thought and idea.

In our school, I was satisfied that we were doing all we could to help keep our young people safe and reduce their anxieties so that they could thrive and flourish within the world they lived. Approximately 90% of our students had communication difficulties, which often led to frustration and caused much of their anxiety.

However, I realised we should be doing more. We had a new focus, a new goal. We wanted to raise aspirations but, unlike mainstream schools, the focus wasn't about raising aspirations in students, but raising the aspirations of employers. We wanted employers, the workforce, to see the potential of those who think differently. And we decided to start with the local community.

We knew that many of our young people would remain in the local community after leaving school. They would continue to be looked after by their families and so educating the local community seemed sensible. We embarked on a series of awareness training sessions, coming at the employers from a range of different angles so that they couldn't escape! We ran open mornings, showing off the brilliance of our students and enticing them in with free tea and coffee.

We also encouraged them to take our students on long-term work experience, offering them free adult



support who acted as job coaches, educating the employer's staff. We took our students to the local businesses, selling the products they had made to local workers and joining them for lunch. We got ourselves on the local enterprise board and eulogised about the skills of our young people. We even opened our own shop, farm and horticulture centre to develop the work-related learning skills needed.

And the result? More and more employers accepted and were keen to take our students on work experience. And best of all the employers sought to engage the students permanently and gave them jobs when they left school.

This example demonstrates one way of supporting the wider community to understand the needs and differences of young people with special educational needs (SEN) and indeed to celebrate them. This is crucial as a significant number of children have SEN.

Importantly, one universal characteristic that runs through this group of children and young people is the



*Director of Education at I CAN, Deirdre Fitzpatrick*

presence of SLCN as this disability is one that cuts across labels and diagnoses. But every child with SLCN is different; they will have their own strengths and needs even if they have an official diagnosis. We continue to strive to help everyone recognise their potential and support them to flourish. ■

**Deirdre Fitzpatrick**  
**Director of Education**

I CAN

Tel: +44 (0)207 843 2515

[info@ican.org.uk](mailto:info@ican.org.uk)

[www.talkingpoint.org.uk](http://www.talkingpoint.org.uk)

[www.twitter.com/ICANcharity](https://www.twitter.com/ICANcharity)



# What twins can tell us about Specific Language Impairment

Mabel L Rice from the University of Kansas explains how studies into Specific Language Impairment can benefit from twins and how they speak to each other

One unexplained kind of language impairment in children is known as Specific Language Impairment (SLI). As the name implies, children with SLI have language impairment “specifically”, i.e., with no other conditions that are known to cause language impairment. The children with SLI do not have overt neurodevelopmental disorders, hearing impairments or other syndromes such as autism spectrum disorder (ASD) or Down syndrome. The causes of SLI are a puzzle, given that language acquisition is very robust in most children despite great variations in other dimensions of children’s development and great vari-

ations in the ways in which families around the world raise their children. It is not necessary for families to explicitly “teach” their children the grammar of their languages; instead, children seem to spontaneously “pick it up” when they are toddlers and quickly increase their abilities thereafter. Yet the children with SLI start their language systems later and are at risk for persistent low language abilities into adulthood.

The cause of SLI is unknown, although there is growing evidence pointing toward the likelihood of inherited risk for SLI. Twin children provide an informative “natural experiment” for

evaluating possible inherited factors contributing to SLI. Here I will summarize the logic of twin studies and outcomes of recent studies that support possible inherited factors on the causal pathway for language impairments such as SLI. I will also note how twins’ language acquisition differs from that of single-born children.

## The case of twins

Twin children are paired in their development before they are born, sharing their mother’s uterus; they are born at the same time and share their home environments as they are raised and grow through childhood. Nature provided essential differences across

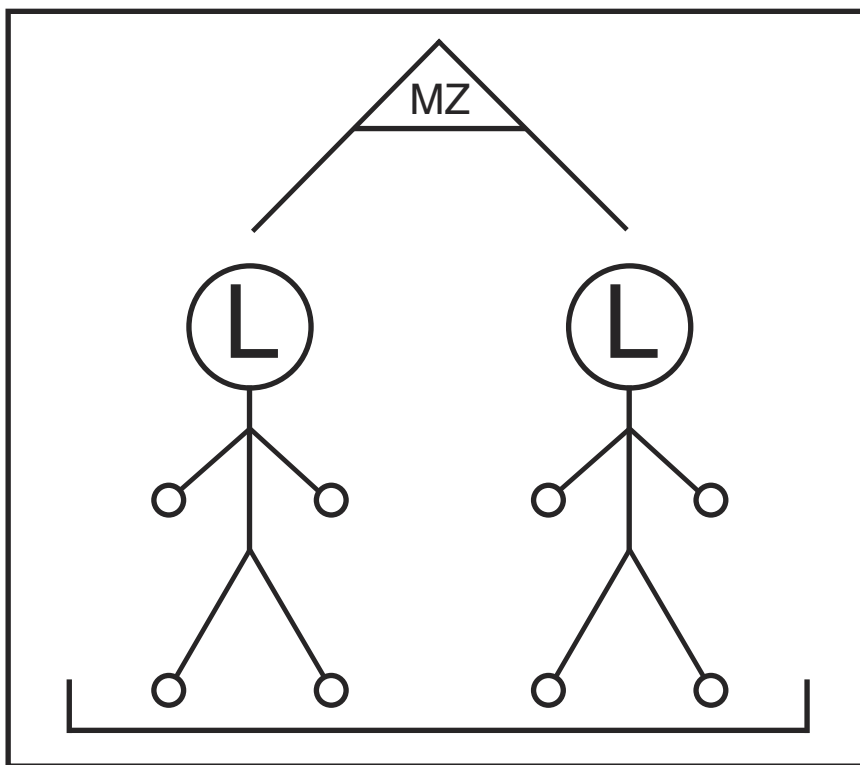


Figure 1: Monozygotic female twins concordant for robust language abilities

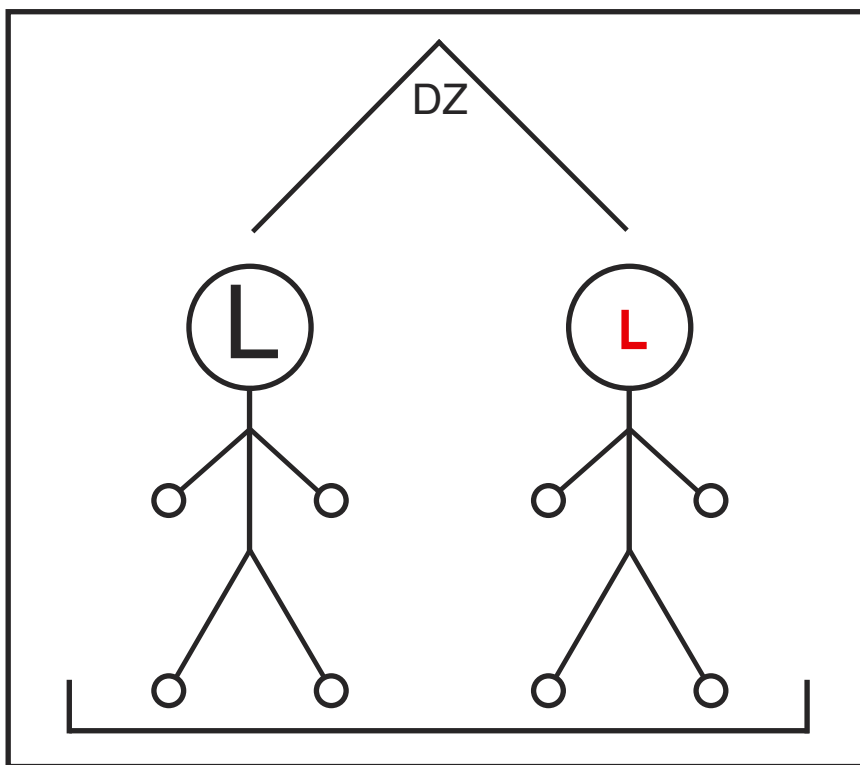


Figure 2: Dizygotic female twins discordant for language ability

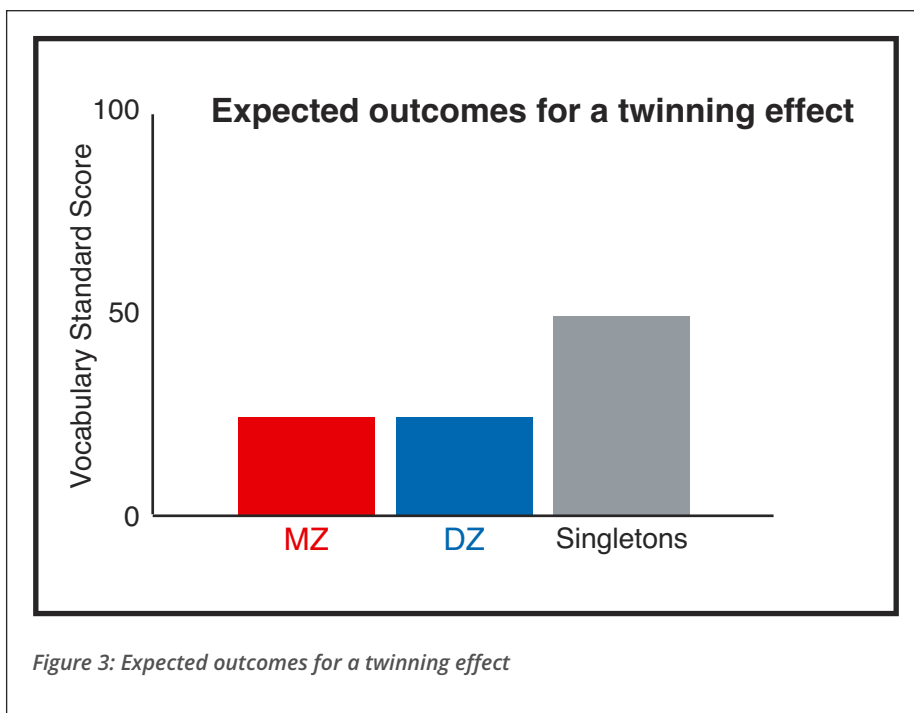
pairs of twins, in the form of two kinds of pairs. Monozygotic (MZ) twins, sometimes called “identical” because they tend to look alike, begin as a single fertilized egg that splits into two, i.e., the two children develop from one zygote, which splits and forms two embryos. Dizygotic (DZ) twins, sometimes called “fraternal” because of their “brotherly” or sibling status, develop from two different eggs, each fertilized from its own sperm cell. Thus, MZ twins can be thought of as “duplicates” genetically whereas DZ twins are siblings who happen to be the same age. MZ twins are the same sex; DZ twins may or may not be the same sex.

Two pairs of twins are illustrated in Figures 1 and 2. Following common scientific conventions for showing pedigree relationships, Figure 1 depicts twin MZ girls, where the circles represent females (males are represented by squares), and the connected diagonal lines above their heads indicate MZ connectedness. In contrast, the DZ twin girls are female siblings without a connecting line between the two pointing lines. In these figures the level of language abilities for each child are indicated by the letter “L” within their heads. The MZ twin pair shares a large black “L” indicating robust language ability. The DZ twin pair has two different language symbols; one twin has a small red “L” instead of the expected large black letter, indicating one of the girls has low levels of language ability. Presence of the same trait, such as language ability, in both members of a twin pair is known as “concordance.”

### The logic of twin behavioral research

Methods of behavioral genetics research build on the notion of





concordance to estimate the sources of similarity and differences within twin pairs. This is represented by the equation  $h^2+c^2+e^2=1.00$ , with “h” for heritability, “c” for environmental effects common to the twin pair, such as the resources of the home, and “e” for environmental effects unique to each twin, such as an episode of meningitis during infancy. Larger values for  $h^2$  are interpreted as increased likelihood of inherited influences on the trait, although the exact molecular genetic mechanisms are not revealed by the method.

### Possible “twinning” effects on language acquisition

At the outset of language acquisition, twins can be compared to single-born children in the acquisition of early language milestones. An open question is whether twins may lag their age peers at the outset of language acquisition. A twinning effect could be related to the additional care required by two babies instead of one. If so, the expected outcomes would be as

depicted in Figure 3, such that, irrespective of the kind of twin pairs, twin children could score lower on early vocabulary acquisition than same age singleton children.

### Outcomes of recent twin studies

**Twinning effects.** Recent studies document twinning effects in the language acquisition of 24-month-old twins<sup>1</sup> and again at 4 and 6 years of age<sup>2</sup>. The outcomes are depicted in Figure 4. The “X” in the figures show that, instead of the expected score of 100 (or, 50th percentile) for their age, the children score a standard score of 90 (about the 25th percentile). Also, the figure indicates that the DZ twin children, on average, score somewhat higher than the MZ twins, a statistically significant difference that resolved by 6 years of age. These outcomes were found across multiple measures of language and speech development at each age level. These findings do not support the notion that a twinning effect is due to the

burdens of raising two children because one kind of twin pairs was less likely to experience twinning effects than the other kind, although the child-raising burden posed by two babies would be the same for both kinds of pairs. Instead, the findings point toward a possible zygoty effect based on differences between the kinds of twin pairs, differences perhaps biological in nature. Twinning effects decreased slightly from 4 to 6 years, with a statistically significant improvement, moving toward the age-level expectations, although the gap is not yet closed with the age peers at age 6 years.

**Heritability outcomes.** Across studies, heritability estimates tend to increase with age, and to vary across the dimensions of language outcomes. For the full sample of twins, at two years of age, heritability is estimated as .25 for vocabulary, .52 (boys) and .43 (girls) for early grammar, and .22 for combining words<sup>1</sup>. At four years of age, heritability is estimated in the range of .10-.73, with the highest estimates for speech and mean length of utterance<sup>2</sup>. At six years of age, the  $h^2$  range is .54-.92 with the highest for grammar and speech<sup>2</sup>. These heritability estimates were from models adjusting for possible effects of perinatal status and external factors such as parental income.

Heritability outcomes also tend to be higher when studying children at the same age level and dividing the group into two, comparing twins in the typical or above range versus children who score below age peers. This can be called “heritability of language impairment” in samples of twins screened for children with clinical diagnosis of neurodevelopmental dis-

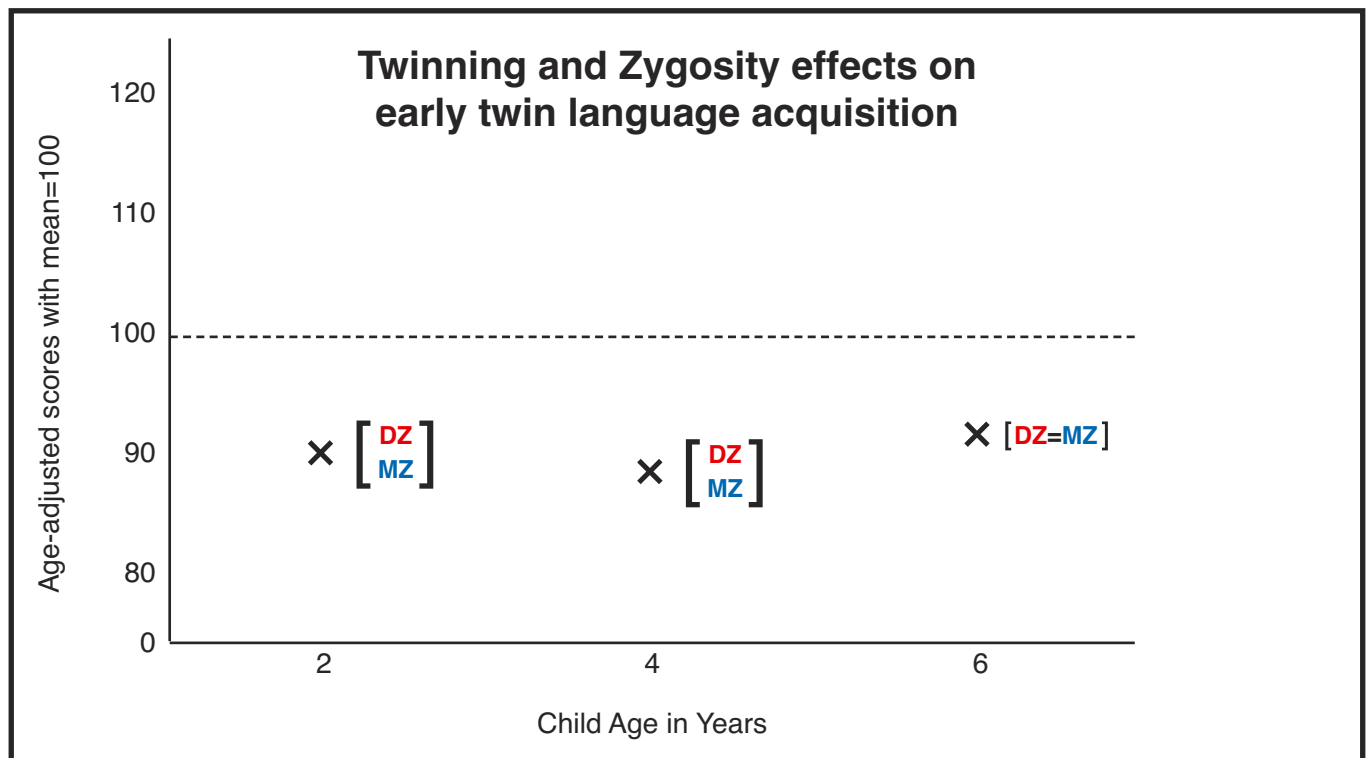


Figure 4: Twinning and zygosity effects on early twin language acquisition

abilities. A recent study of 16-year-old twins reported substantial heritability for language impairment<sup>3</sup>. For a grammar task, the estimates for genetic influence on low performance levels ranged from .36 with the criterion of the lowest 10% of the group to .74 with the lowest 5% of the group.

### Lessons from twin studies for understanding SLI

Inherited influences on language acquisition in young children are suggested by heritability estimates from studies of twin children, although the exact molecular genetics are not yet identified. Although environment plays a role in language acquisition, the possibility of stronger inherited effects for children with levels of language substantially below age expectations further adds to the support of likely inherited influences in the causal pathways for SLI. Studies

of twins suggest that heritability increases with age and is stronger for some dimensions of language than others, with grammatical abilities perhaps more heritable than vocabulary, for example. An important caveat from twin studies is that it is very important to be mindful of possible twinning effects on language in young twin children, effects which differ from the condition of SLI. On the other hand, a better understanding of the causes of twinning effects on language could help reveal characteristics of cortical development that guide language acquisition in young children or that are immature in children with SLI.

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**KU** THE UNIVERSITY OF KANSAS

**Mabel L Rice**  
University of Kansas  
Tel: +1 785 864 4570  
mabel@ku.edu  
www.ku.edu

# The evolution of higher education in Macao

Two academics provide an expert perspective on the compelling story of higher education in Macao, China

The evolution of higher education systems is a subject relating to many different aspects of any society, from operational and financial matters to ones that define the understanding and expression of citizenship. Some specific geographical areas, such as Macao, have been at the forefront of policy experimentation with regards to changes in their higher education structures and as such offer a unique example of continuous system change.

The Portuguese came to Macao in 1553 and with the permission of officers of the Ming Government,<sup>1</sup> set up their first settlement in the Far East. In 1987, China and Portugal reached a consensus about Macao's reversion to China in 1999. After becoming a special administrative region (SAR) of China, Macao experienced a rapid economic development which was also reflected particularly strongly in the educational field.

**“Since 1999, the rapid financial development of the region was reflected in the rapid development of its higher education establishments and the increasing demands for further education provision by the population.”**

In summary, this article presents a brief review of the challenges, progress, and changes on the tertiary educational system of Macao over the last two decades, using as an exemplar the case of the University of Macau, the largest such institution.

## The legacy

As one of the first and primary places in the world where East met West, Macao became an open window to the rest of the world for China. The first European-style university in the Far East was established by the Jesuits in Macao in 1594. The St. Paul's College was upgraded from a school offering language lessons and



religious education, to a college providing university-level instruction.<sup>2</sup> The College quickly “became a symbol of Western-style education”,<sup>3</sup> yet was abandoned in 1762 because of political strife within Europe.<sup>4</sup>

The first modern higher institution of Macao, the University of East Asia (UEA), was established in 1981.<sup>5</sup> However, UEA was a private university aiming to serve the surplus demand of Hong Kong and addressing the educational needs of neighbouring regions. After the signing of the joint Sino-Portuguese declaration in 1987, the nurturing of local talents was defined as an important ingredient for stability and transition to the



handover era, while the public demanded greater government inputs in education. As a result, in 1991 the Government of Macao acquired UEA and created the University of Macau (UM), by this time it was one of the youngest such institutions in Asia.

### Changing vision, mission and curriculum

Moving from being private- to publicly-funded, UM had to undergo substantial changes in terms of structure and governance. It set up a University Council, Advisory Committee and Senate; reformed curricula and launched research institutions.<sup>6</sup> The target audience of higher education focused at this point to the local population, aiming to develop local skills and capacity. ‘Localisation’ was exhibited by increasing subjects and postgraduate programs linked to the local needs. These included subject areas, such as public administration, laws, business, education, science and technology, relevant to the local employment market.<sup>7</sup>

Since 1999, the rapid financial development of the region was reflected in the rapid development of its higher education establishments and the increasing demands for further education provision by the population. The difference in the relative size of campuses is a very apt demonstration of this growth in the

demand/supply chain. In 2009, the Central Government of China authorised Macao SAR to exercise jurisdiction over the UM new campus at Hengqin Island, where UM was relocated in 2014.<sup>8</sup>

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**“The concurrent understanding of east and west forms a distinctive part of the local identity. The higher education system increasingly incorporates this element into the academic disciplines on offer and their potential impact.”**

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The size of the new campus is almost 20 times larger than the previous one. This rapid development and creation of a wider educated public also generated pressures linked to performance – institutions now had to perform in a highly visible and competitive regional environment. UM ranked 351-400 in the Times Higher Education World University Ranking in 2018, compared to 2004 when it could not be found on the list.<sup>9</sup>

The concurrent understanding of east and west forms a distinctive part of the local identity. The higher education system increasingly incorporates this element into the academic disciplines on offer and their potential impact. For example, UM is home to the State Key Laboratory of Quality Research in Chinese Medicine (QRCM), which



opened in 2011. QRCM is aiming to develop innovative medicines through R&D; local and international registration in the EU and Portuguese-speaking countries, of advance therapies based on combined treatment using Chinese and Western medicine. QRCM forms a very interesting case example – where Chinese medicine is studied against international standards for safety, quality and efficacy – combining both legacies under one roof.<sup>10</sup>

### The future and challenges

Following its sustained growth over the last two decades, Macao now aims to diversify its economy and develop higher education as a major pillar of the economy, moving from 'localisation' to 'globalisation' and completing a full circle in engaging east and west within higher education. It is a strategic direction that a market-oriented system for university-led innovation is to be sought.

**“The size of the new campus is almost 20 times larger than the previous one. This rapid development and creation of a wider educated public also generated pressures linked to performance – institutions now had to perform in a highly visible and competitive regional environment.”**

However, training and retaining talent in a highly competitive regional environment remains a key concern. The expansion of direct admissions offered by universities in mainland China will cause a drastic increase in the competition for outstanding students, while the rapid development of higher institutions in the neighbouring region and increasing income of local inhabitants could encourage the pursuit of higher education overseas. The future challenges are many and will remain firmly rooted between better serving the needs of the local and regional community, whilst also creating a stronger impact globally. ■

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### Zisis Kozlakidis

Division of Infection and Immunity  
University College London  
Tel: +44 (0)20 7836 5454  
[z.kozlakidis@ucl.ac.uk](mailto:z.kozlakidis@ucl.ac.uk)  
[www.ucl.ac.uk](http://www.ucl.ac.uk)



### Kai Chun LEUNG

**Adjunct Assistant Professor,  
Faculty of Social Sciences**  
University of Macau  
Tel: +853 8822 4280  
[chrisleung@umac.mo](mailto:chrisleung@umac.mo)  
[www.umac.mo](http://www.umac.mo)  
[www.twitter.com/kingscollegelgn](https://twitter.com/kingscollegelgn)



# Public, private, or a mix?

## How to best finance infrastructure

The UK must improve the way it decides between infrastructure finance options if it wants to pick the best value finance options, argues Graham Atkins from the Institute for Government

The UK government is planning for £242 billion of public and private infrastructure investment between 2016/17 and 2020/21 (see fig. 1).

A large number of these projects will be privately financed – primarily those in energy, utilities and communications (see fig. 2):

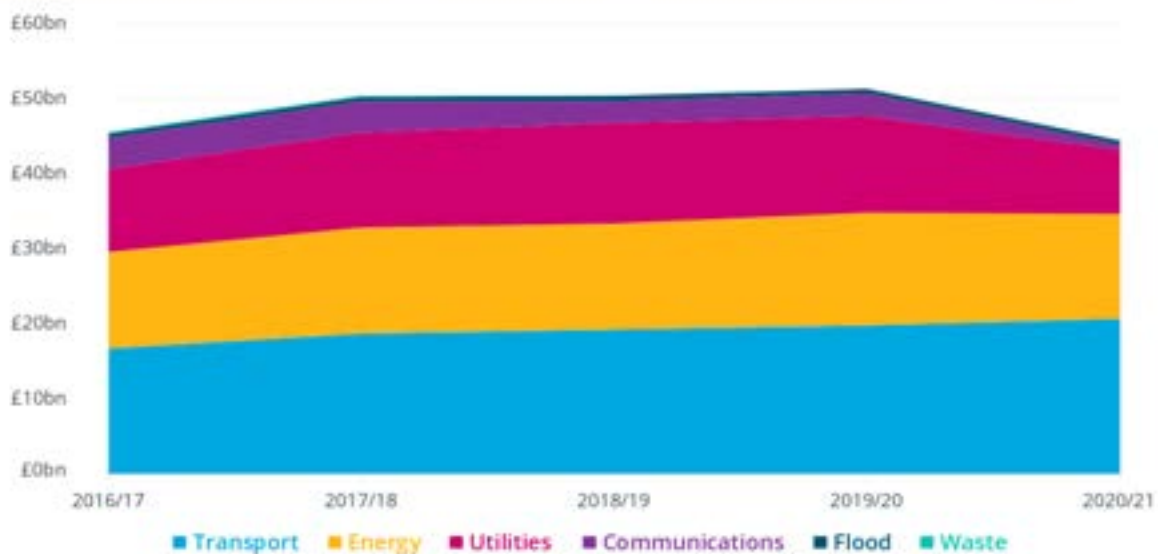
The government needs finance to meet the upfront costs of a range of new projects. But in the past, governments have not made good finance choices. There are examples of success, such as Thames Tideway, but there are many examples of inappropriate finance choices leaving taxpayers and consumers locked into expensive and inflexible contracts.

Governments struggle to pick the options which deliver the best value over the long-term. A recent Institute for Government report, *Public versus private: how to pick the best infrastructure finance option*, identified three key challenges the government faces when trying to select the best finance options:

### Accounting

The UK's accounting standards mean that 90% of private finance projects do not count towards public sector debt. Being effectively 'off balance sheet', ministers may choose to use private finance because it does not contribute to public sector debt, rather than it being any better value.

Planned public and private investment in UK economic infrastructure annually, 2016/17-2020/21



Source: Institute for Government analysis of IPA, National Infrastructure and Construction Pipeline, 2017

Fig. 1

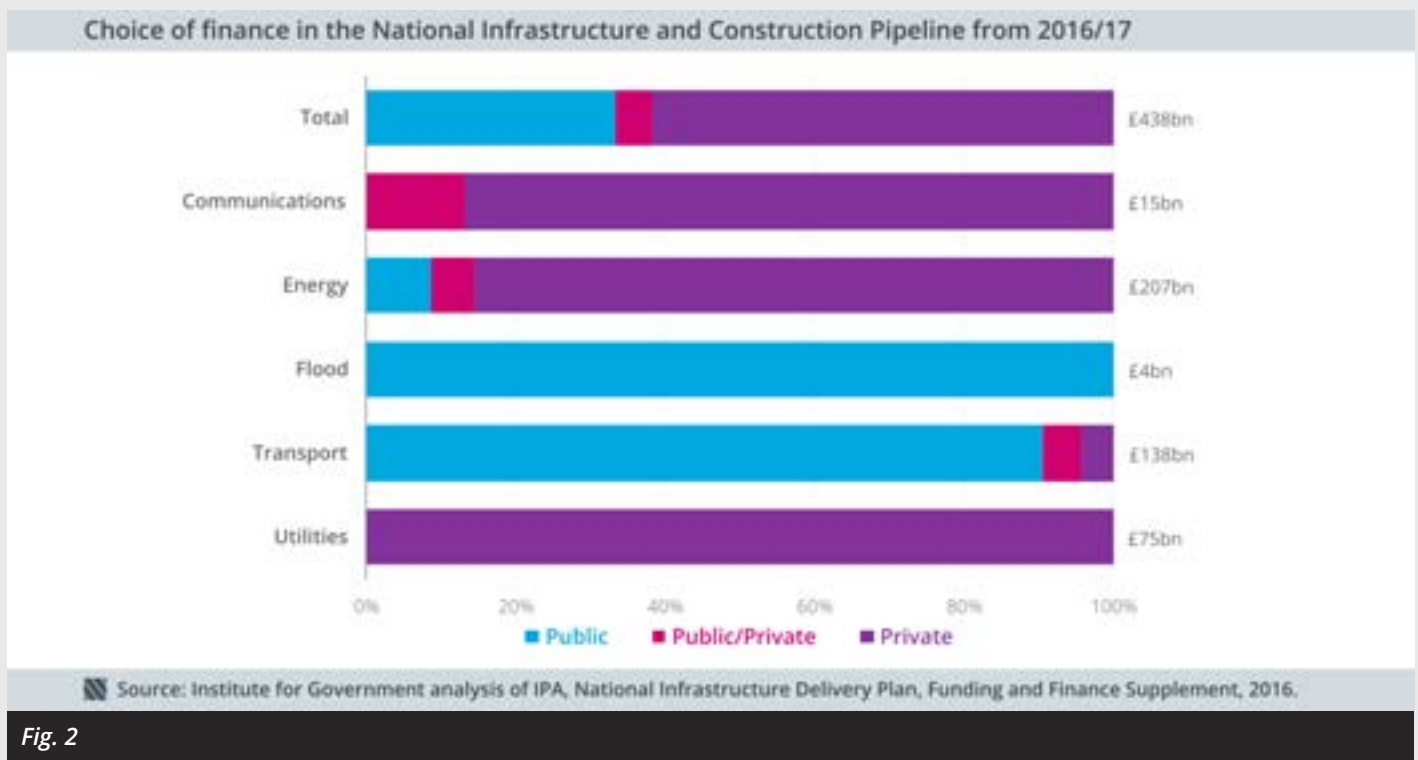


Fig. 2

The government cannot let arbitrary accounting rules and narrow fiscal targets drive financing decisions. ‘Off balance sheet’ projects will not always be the best value, especially if the government tries to transfer risks or uncertainties which it is better placed to bear.

For example, past private finance contracts have limited public ownership and transferred construction risks, even in highly complex projects. This appears to have been to ensure off balance sheet treatment.

The UK has more off-balance sheet private finance projects than most other European Union countries (see fig. 3).

To mitigate the impact of partial accounting undermining comparisons between finance options, public authorities must publish their comparison of finance options using wider measures of public sector debt and liabilities. Being transparent about the assumptions and the evidence underpinning comparisons would allow informed auditors to improve decisions.

In addition, the Chancellor should expand the fiscal remit of the National Infrastructure Commission to include private finance. Expanding the remit would reduce the temptation for ministers to choose private finance to game spending targets.

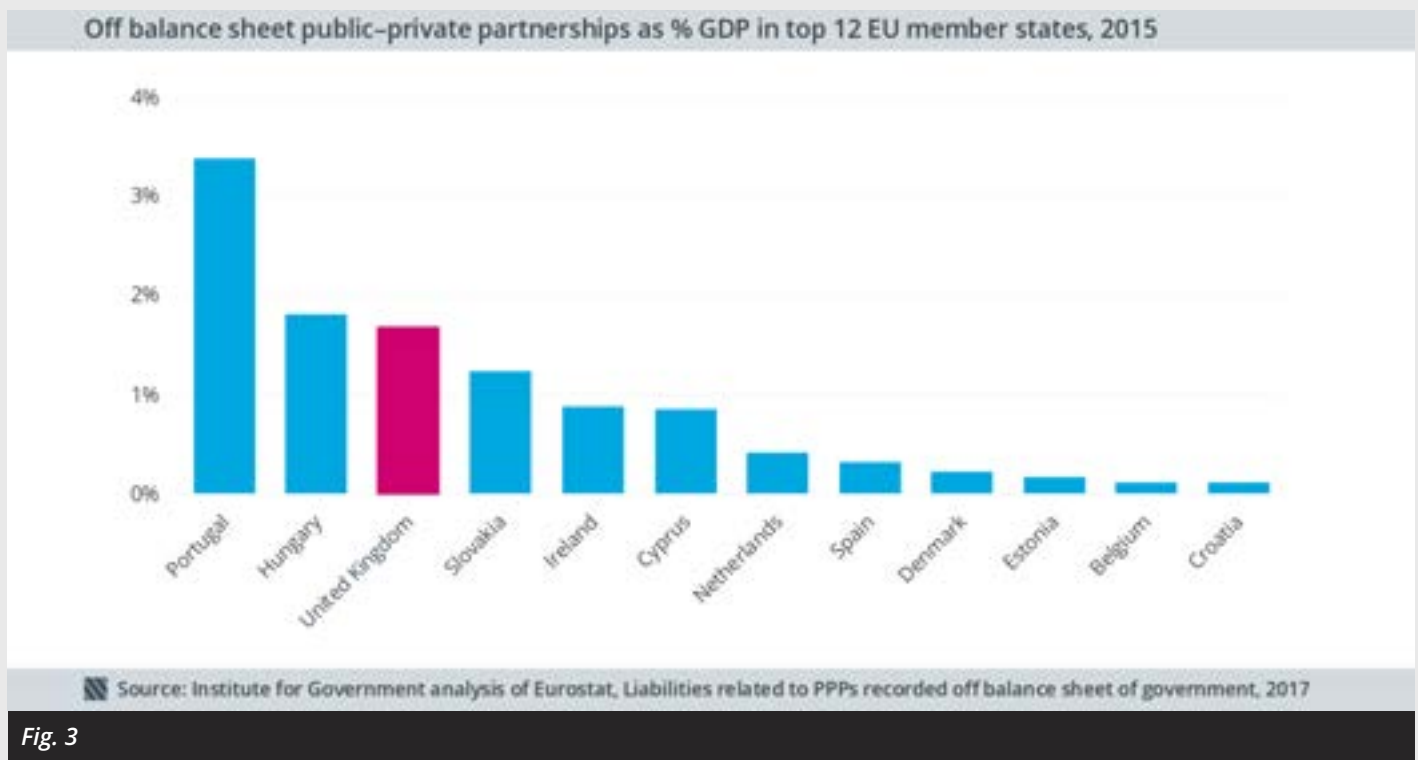
## Appraisal

The government must compare finance options fairly. Appraisal would be improved if it were underpinned with the latest data on the costs and benefits of different finance options. The starting point is data collection. The Infrastructure and Projects Authority – the government’s centre of expertise on private finance – should mandate departments to collect and collate evidence on the cost and quality of past publicly and privately financed projects.

At present, the multiple responsibilities of those comparing finance options undermines assessment. Project teams who compare options are often intimately involved in the project and usually have preferences for it to be publicly or privately financed.

Because of the lack of data, these teams and their consultants have ended up relying on their own experience to predict the likelihood and impact of certain risks. This is not good practice. Relying on the perceptions of people closely involved with specific project risks underestimating the costs, times and risks of their favoured options.

Those undertaking appraisals must have the incentives in place to provide objective advice. Creating separate teams within departments, or a separate team within



the Infrastructure and Projects Authority, would improve the current situation.

**“Governments struggle to pick the options which deliver the best value over the long-term. A recent Institute for Government report, Public versus private: how to pick the best infrastructure finance option, identified three key challenges the government faces when trying to select the best finance options...”**

## Budgeting

Even where private finance is likely to deliver less value compared with public finance, the way the Treasury allocates money incentivises departments to use private finance. Private finance has a faster sign off than standard capital spending, short spending reviews make public finance uncertain and limited capital budgets can make private finance look unduly attractive.

To avoid this the Treasury must plan capital budgets on a longer-term cycle, assuming that the government will spend 1-1.2% of GDP on economic infrastructure every year – the same remit given to the National Infrastructure Commission.

Within that 1-1.2% commitment to infrastructure,

some money must remain unallocated, so that it can be used for projects which emerge outside of Spending Reviews. Without some fiscal headroom, there would be a danger of defaulting to private finance for these projects.

The UK can improve the way it decides how to finance infrastructure projects. Decisions about how to finance infrastructure projects must be based on evidence that the financing option selected will deliver the best value. They cannot be based on arbitrary accounting rules or anecdotes.

None of these challenges are insurmountable and the reforms the Institute for Government outline will help the government pick the best finance options more often. ■

**Graham Atkins**  
**Researcher**

Institute for Government  
Tel: +44 (0)20 7747 0422  
[www.instituteforgovernment.org.uk](http://www.instituteforgovernment.org.uk)  
[www.twitter.com/instituteforgov](https://twitter.com/instituteforgov)



# Cross-sector procurement: Whereby birds of a kind flock together

Paul Lloyd from The Public Purse explores the key issues around cross-sector procurement

**D**ecentralisation and autonomy are vital to our concepts of good and effective local government. It's also important to all public bodies, such as the blue lights, healthcare and the education sector. The ability to make their own decisions relative to their field of activity means unwelcome restraints are not present and nor should they be.

Over recent years, neighbouring city and county councils have been merging front line and backend services for several years to achieve significant and worthwhile savings. Typically, shared backend services have included HR and finance.

The beauty of cross-sector collaboration as a concept is that it takes the best from both extremes. A form of natural selection takes place whereby birds of a kind flock together. We see joined-up public-sector procurement happening between police forces, between NHS trusts as well as between fire services, education and local authorities, all working in unison.

This takes several forms. There are procurement consortia and procurement hubs, which draw existing procurement resources to a central operation and which are owned and funded by the public bodies they serve. There are also some privately-owned groups, which effectively offer a procurement outsourcing service. Some bodies simply outsource their own procurement to another public body.

The undeniable attractions are the much higher combined purchasing volumes that immediately attract more competitive pricing from suppliers. Furthermore, a joint effort provides more purchasing power to the public sector, therefore, applying more pressure for the suppliers to provide a more valued proposal.

Overall fewer supply chains and suppliers to manage

and ultimately, fewer resources are required to execute the procurement function.

There is a cost, of course, and a significant part of that is simply the extra personnel and resources consumed by executing tasks that are duplicated up and down the UK. The other part is the organisations being unaware of the current opportunities that fly by them each day.

The trouble is that organisations will continue to spread one's wings, occasionally by flying with favourite partners, until the evidence of cross-sector based collaboration concludes with a comfortable flight.

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**“The government would do well to recognise the power of initiative. After all, the end game is to provide public services at vastly reduced costs, achieved by continuously shrinking budgets. No matter how you sugar the pill, that implies job losses and lack of funding for services.”**

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Furthermore, political agendas will always be problematic, even if presented with a saving cost opportunity and therefore organisations lose out on additional funding for improving resources, services and increasing wages.

Presently, the unfair balance of time and money pressure in procurement creates day-to-day challenges and potential rash decisions

So, should the public-sector fly in unfamiliar territories and essentially risk a contract supplier for a cost-saving opportunity? Would public sector procurement increase the percentage of collaborative opportunities with insight into suppliers? Given insight, organisations would benefit from being partners first, sharing best practice and lending a helping hand to each other's challenges. This would be achieved by sharing real-time supplier information and benefit the process before beginning a



framework agreement. Furthermore, organisations would find further cost saving opportunities in the current no-fly zones of cross-sector.

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**“The beauty of cross-sector collaboration as a concept is that it takes the best from both extremes. A form of natural selection takes place whereby birds of a kind flock together. We see joined-up public-sector procurement happening between police forces, between NHS trusts as well as between fire services, education and local authorities, all working in unison.”**

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The government would do well to recognise the power of initiative. After all, the end game is to provide public services at vastly reduced costs, achieved by continuously shrinking budgets. No matter how you sugar the pill, that implies job losses and lack of funding for services.

So, is it the case, that the more efficient that procurement officers become at delivering their area of expertise to their public-sector employers and clients, the more they are undermining their own job security as a group?

That is a significant, if a generally unspoken, disincentive to progressive procurement collaboration on a voluntary

basis. It is to the credit of the UK's public servants in the procurement arena that they have already achieved so much and continue to strive for greater efficiencies to stretch the public purse.

After 15th January this year, The Public Purse, United Kingdom-based think tank will begin its journey 'Whereby birds flock together' in a bid to encourage cross-sector collaboration, by providing initial collaboration reports to interested bodies of UK based central & local government, education, blue light and healthcare. ■

**Paul Lloyd**  
**Brand & marketing director**

The Public Purse  
Tel: +44 (0)845 533 9095  
[info@thepublicpurse.org.uk](mailto:info@thepublicpurse.org.uk)  
[www.thepublicpurse.org.uk](http://www.thepublicpurse.org.uk)  
[www.twitter.com/thepublicpurse](https://twitter.com/thepublicpurse)

# 2018 outlook: Marginal gains and long shots in procurement and accounts payables

Sam Mazloum, Director of Public Sector at Mastercard shares an expert perspective on what the public sector should look out for in 2018 in terms of procurement and accounts payables

In the world of elite sport and in business, world-beating performance has been delivered through both low-risk marginal gains and far riskier investment in long shots – think of British Cycling’s electrically heated hot pants versus the Fosbury Flop – or Google’s experimentation with 41 shades of hyperlink blue versus the lightbulb. Each of these advances has transformed the performance of individuals, teams, organisations and even society.

With 2018 well underway, where are the marginal gains and long shots that could transform public sector procurement and accounts payable this year and beyond? Firstly, let’s have a look at a couple of marginal gains.

Electronic invoicing – It’s been around for over 30 years and not yet fulfilled its potential, despite EU directives and the prompt payment code providing the political impetus. However, it is the proven ability to more easily integrate complex systems and processes and automate supplier payments where the opportunity will be realised in 2018.

Large government departments and local authorities are now able to use eInvoicing, in areas such as contingent labour and pay suppliers within 48 hours, replacing manual processes and weeks long reconciliation and payment timeframes. In 2018, you too

can turn accounts payable from a cost centre to a profit centre.

**“Making the most of the marginal gains on offer will deliver you transformation in 2018, but don’t take your eye off the long shots, because one day one of them could change not just your organisation, but the whole industry.”**

Payment Services Framework – 2018 will see the fifth iteration of what was previously known as the Government Purchasing Card. Great innovation in the way we pay for goods and services as consumers over the last 20 years has been matched with similar progress in B2B payments. The availability of virtual cards, enhanced data, ERP integration, simple supplier onboarding, greater control, reconciliation and audit capability are just some of the developments. Combined with a requirement for card payment in most new Crown Commercial Service (CCS) frameworks, this means that there has never been a better time to pay by card. And yes, you are still protected by chargeback rules and you still get a rebate. Now for the long shot.

Electronic marketplaces – It is their ambition in 2018 that makes them a long shot. In the last two years, Amazon has invested heavily in people and technology to give the scale, control and data from the payment networks that B2B demands. CCS too is aiming to

go beyond IT and stationery that the beta Crown Marketplace as delivered so far. The vision of a unified guided buying platform for all common goods and services, combining the ease of the consumer experience with the robustness and data of a genuine B2B platform, will take some time, but at least we expect the procurement to take place in 2018. In the meantime, Basware who provide the government eMarketplace, continue to add both content and buyers.

Making the most of the marginal gains on offer will deliver you transformation in 2018, but don’t take your eye off the long shots, because one day one of them could change not just your organisation, but the whole industry.



**Sam Mazloum**  
**Director, Public Sector UK & Ireland**  
 Mastercard  
[ukpublicsector@mastercard.com](mailto:ukpublicsector@mastercard.com)  
[www.mastercard.co.uk](http://www.mastercard.co.uk)  
[www.twitter.com/MastercardUKBiz](https://twitter.com/MastercardUKBiz)

# Public Sector eProcurement at its very best.



INTEGRATION



TRANSPARENCY



CONTROL



EFFICIENCY

**Purchase & Pay** is an innovative new part of Crown Commercial Service's Government eMarketplace. It is a fully flexible end-to-end procurement platform enabling you to pay for products and services online in a secure cloud environment. It can be fully integrated with your finance and procurement systems or used as a standalone solution.

By combining Royal Bank of Scotland and Mastercard's payment innovation with the Basware Commerce Network, Purchase & Pay gives you complete control over your finances. Transaction detail is captured at line level giving you spend visibility to support VAT reclaim and enabling automated reconciliation.

The platform delivers

- Procurement compliant purchasing
- Enhanced security
- Process efficiency
- Improved reconciliation
- Prompt payment
- SME inclusion
- Reduced accruals
- Working capital improvement



mastercard.



To learn more about Purchase & Pay contact  
your Royal Bank of Scotland banking team or  
[ukpublicsector@mastercard.com](mailto:ukpublicsector@mastercard.com)



# UK's Industrial Strategy falls way below expectation

Nigel Wilcock from the Institute of Economic Development provides his opinion on the UK's Industrial Strategy in terms of the future economy of Britain

If you weren't watching carefully, the UK's Industrial Strategy was published in November 2017. Launched on the day of the Royal Wedding announcement and followed by Brexit machinations it has not gained much airtime.

Yet, this should be a very big deal. In July 2016, Theresa May announced her new government and said, 'industrial strategy' will be at the heart of it. At the time this was seen as a side swipe at George Osborne because her "proper industrial strategy" would support the UK's great regional cities – in contrast, many said, to the policy light/rhetoric heavy Northern Powerhouse.

So now we have it – some 16 months after the idea was announced. The first all-encompassing national economic strategy in living memory. A document that should drive all government decisions that are likely to impact on the economy and a document to which local policy-makers and industry should be able to turn and rely on as the touch point to align their future decision-making. As it turned out, 254 pages to shape the future economy of Britain.

Well, it is easy to throw stones, but the first observation is that this is not really a heavyweight considered strategy for the future of the British economy. As one colleague put it, it is written in the style of a university prospectus. Every idea linked to a shaded box giving us an example or quote from a business or initiative. This is that 'show-business makeover' of an industrial strategy that seems to be infecting even the most heavyweight of government strategies.

Nevertheless, the Institute of Economic Development (the UK's independent professional body for economic development and regeneration practitioners) is pleased to see that a strategy now exists – a concept



*Nigel Wilcock, Executive Director*

that we hope will continue. We also applaud the idea that local industrial strategies will allow the national concepts to feed down. This seems highly logical, allowing a local contribution where relevant within the framework of the overall strategy.

So, what did we like? The Industrial Strategy sets out grand challenges around which economic effort can coalesce – big data/AI, ageing, mobility and clean growth. This seems a useful way of conceiving future activity. The Industrial Strategy also defines the 5 foundations for future performance – people, ideas, infrastructure, business environment and place. It does seem that these challenges and foundations provide a structure for local entities to determine their own approaches.



After this, the detail failed to deliver. In fact, the document that promised to be at the heart of government contains very few genuinely new strategic initiatives. Science and technology – and the Industrial Strategy Challenge Fund – are central. But when a strategy summarises its three largest initiatives to tackle the issues around the different performances of place and quotes “to provide £42 million to pilot a Teacher Development Premium. This will test the impact of a £1,000 budget for high-quality professional development for teachers working in areas that have fallen behind”, it is clear you’re not reading a heavyweight strategic document.

Whilst we generally applaud the concept of an Industrial Strategy, the published strategy falls way below expectation – and, in fact, it could be argued that this isn’t a strategy at all. We consider the (voluntary) contribution of the Industrial Strategy Commission to have been a far more valuable analysis and determination of the future than has been provided. One of the most useful aspects of their work was also the governance and mechanisms to create a performance feedback loop and hold policy-makers and delivery agencies to account.

So, what is the Industrial Strategy? It is largely rhetoric with a few ideas in a good structure dressed up as a strategy. It completely ducks dealing with regional imbalance and governance/performance measurement. It passes a very large amount of thought and implementation locally – with the usual issues of resources to deliver. So, in all, a missed opportunity – but let’s build on this – at least we now have a strategy and on balance, this is better than the approach of the last decades where we had no strategy at all. ■

**Nigel Wilcock**  
**Executive Director**

Institute of Economic Development  
Tel: +44 (0)1925 730 484  
[admin@ied.co.uk](mailto:admin@ied.co.uk)  
<https://www.ied.co.uk/>  
[www.twitter.com/theied](https://twitter.com/theied)

# Adapting defence technology to business enterprise: Autonomous unmanned vehicles

Paddy Bradley, Director of the Swindon and Wiltshire Local Enterprise Partnership outlines the development of autonomous vehicles technologies for today's defence industry

The development of autonomous vehicles technologies has the potential to revolutionise logistics and distribution from the use of drones through to innovation in agri-tech and energy applications. Defence industry-related activity in this area will be the catalyst for growth and new technology development in this field in Swindon and Wiltshire and relates well to the foci of the Industrial Strategy Challenge Fund. The opportunity is there to transform the technology of military drones into commercial and public-sector applications.

## Defence technology

The defence industry has led much of the development of unmanned autonomous vehicles on land, sea and in the air. The growth of technological developments and applications are continuing to expand at a rapid rate. IHS Markit<sup>1</sup>, a business providing critical information, analytics and solutions for the major industries and markets that drive economies worldwide, commented in January 2017 that over the next 10 years sales of unmanned military aerial vehicles will exceed \$82 billion globally, involving 63,000 new vehicles. Many of the unmanned ground vehicles, such as those used in combatting the threat of improvised explosive devices, were delivered to more than a decade ago. The IHS forecast is for sales of circa 30,000 vehicles up to 2025, largely to replace the existing stock with technologically more advanced applications.

Civil drone



Image: © Callen-Lenz Associates Limited

Between 2016 and 2025, approximately \$4.9 billion will be spent on unmanned ground vehicles globally. Unmanned sea vehicles have been used for decades for mine hunting and exploration, but are still at a relatively early stage of development. The growth in sales for unmanned sea vehicles will be \$900 million by 2025, compared to the growth of \$800 million for unmanned ground vehicles. Globally, sales of unmanned sea vehicles will reach \$6.5 billion by 2025. The overall market for military unmanned vehicles is huge and growing, accounting for sales close to \$100 billion over the next decade.

## Commercial development

Albeit at a much earlier stage of development and with a smaller market, we are beginning to see applications of drone technology within the private

and public sector. Dorset Police recently announced the creation of a high-tech drone unit and in so doing are amongst the first police forces to deploy such technology through a dedicated unit.

In collaborative research, the forces across Dorset, Devon and Cornwall began exploring drone use in November 2015. The drones will be used in missing person searches and crime scene photography, as well as major traffic collisions. They will also track along the 600 miles of the Dorset coastline to help combat wildlife crime. They will provide operational support across Dorset, Devon and Cornwall. Drones can reach sites of emergencies quicker than road vehicles and are already operating to send aerial video to emergency planning teams. Delivery of first aid equipment and drugs by





Commercial drone

drones will also enhance survival chances of victims of emergencies.

Private use of drones has caused a lot of concern due to the irresponsible and highly dangerous flying of drones near airports and in planes' flight paths. The government's intention to introduce licensing of drone flying is welcomed. Thankfully, there are already businesses that have taken a responsible route to the exploitation of drone technology and are registered with the Civil Aviation Authority. Commercial aerial photography is an obvious development from initial military use to spy on forces and activity from a safe height and in a largely undetectable unmanned vehicle. It provides a cheaper alternative to photography from fixed-wing aircraft or helicopters, whose technology also emerged from military use. For example, in the earlier example of Dorset police's use of drones, they are deploying unmanned vehicles costing in the region of £1,300 to £2,000. Thermal cameras for drone application cost £6,000 and a zoom camera £800. Helicopters cost the police about £800 per hour. The num-

bers do add up for drone use and the equipment costs will only reduce as deployment increases.

Drones enable a range of applications as the size and manoeuvrability of the vehicle to enable it to get close in and take detailed pictures of small features. This capability lends itself well to inspections of buildings and surveying of sites. It is also a boon to people looking for dramatic views to market products, ideas or sees the impact of a large infrastructure improvement such as a major road or rail-bridge or the regeneration of a city centre site.

Drone technology is also helping to open up the world of planning and development of new and heritage buildings. Using the ability of cameras on drones and application software to render levels of accuracy to millimetres, potential clients and members of the public can see what a building looks like now in its current setting, what the views are like from the building and how light and shadow play out during a day. The new design can be incorporated into the aerial photogra-

phy to show the proposed updated arrangement and what will change and what will remain the same. Most people find it difficult to translate a two-dimensional drawing into a three-dimensional view in their mind. We can already translate a drawing into a three-dimensional image on a computer screen and with high-resolution is already a much-improved product. The merging with actual aerial photography takes the proposition further. It has the great potential to make better-informed decisions about building design, planning decisions and can really make public consultation worthwhile and widely accessible.

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**“Drone technology is also helping to open up the world of planning and development of new and heritage buildings. Using the ability of cameras on drones and application software to render levels of accuracy to millimetres, potential clients and members of the public can see what a building looks like now in its current setting, what the views are like from the building and how light and shadow play out during a day.”**

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## Use in agriculture

There is exciting research being carried out by Harpur Adams University, in collaboration with Precision Decision Ltd into an alternative approach to robot farming. They have called the project the “Hands Free Hectare”<sup>2</sup>. The aim is to carry out a full farming cycle from preparation of the land, planting, maintenance and harvesting without any human setting foot on the field. The site will be developed by unmanned ground vehicles and overflying drones controlled by humans using application software. It is the case that a modern farm tractor can already use GPS to decide where, for example, to deposit





Level 2 Land-based student Ben Clothier sets up the GPS system on the driverless tractor at Wiltshire College Lackham

pesticides and fertilisers and how much in each case.

**“There is exciting research being carried out by Harpur Adams University, in collaboration with Precision Decision Ltd into an alternative approach to robot farming. They have called the project the “Hands Free Hectare”<sup>2</sup>. The aim is to carry out a full farming cycle from preparation of the land, planting, maintenance and harvesting without any human setting foot on the field.”**

Making the tractors fully autonomous is the next logical step. However, the Harpur Adams study is looking at this issue from a different viewpoint. Existing tractors are heavy, which means they can crush and compact the soil, which reduces yield and their size limits their accuracy when spraying the expensive chemicals. The Harpur Adams team is using prototypes of smaller, lighter and cheaper vehicles which will leave the soil in good condition and can deploy chemicals with

pinpoint accuracy. The debate is yet to be decided as to whether farming in the future will be dominated by a few large, self-driving tractors or a fleet of smaller robot machines. It is likely the decision will be different on the plains of the USA and East Anglia in this country compared with more compact farms elsewhere in the UK.

## Ploughshare

The story of transforming defence technology into commercial, business enterprises would not be complete without a mention of Ploughshare. The business was established in 2005 as DSTL's Technology Transfer Office to actively pursue the commercialisation of publicly funded research for the benefit of all, whilst supporting DSTL's obligations to the MOD. It does this through a mixture of license agreements and the establishment of spin-out companies. The process of releasing the economic potential of public sector research establishments is often a complex, lengthy with a high degree of uncertainty.

The research at places like DSTL may be at quite a fundamental level and many steps away from commercial exploitation. Despite these difficulties, since its inception, Ploughshare has commercialised more than 120 technologies and launched twelve spin-out companies, principally for civilian applications. It anticipates that by 2018, its license agreements will have created more than 500 high-value jobs, generated exports to the value of £223 million and attracted £130 million of external investment.

We are now seeing the civilian benefits of years of military research and development. Markets are now well established, surpassing known military spend and economics drives further innovation. We are witnessing cross-over and integration of systems as different sector specialists share ideas and learn from each other. The UK is in a position to consign to the dustbin, the oft-used adage that we are not good at converting research into commercial applications. From defence technologies, business enterprises are thriving.

<sup>1</sup> Militaries Ramping Up Use of Unmanned Ground, Sea and Air Vehicles, IHS Markit Says, press release 9 January 2017.

<sup>2</sup> BBC News Report 13 December 2016.



## Paddy Bradley Director

Swindon and Wiltshire LEP  
paddy.bradley@swlep.co.uk  
www.swlep.co.uk  
www.twitter.com/swlep

# The importance of smarter working practices in government

MF Warrender of Open Access Government explores the importance of smarter working practices across government

Established in 2010, The Government Property Unit (GPU) works with central government departments, striving to drive savings across the government estate. Added to this, the GPU works with local authorities to support them in achieving cost-effective local public-sector estates, which can support the delivery of better integrated public services and exploit surplus land and property for growth. Since 2010, over £1 billion has been saved in running costs, showing the significant progress that has been made since the GPU's founding 7 years ago.

More recently, the GPU has been working together with Common Technology Services (CTS), to provide correct and effective technology to make sharing buildings easier within the public sector, as it is a high priority for the government to use buildings in an efficient and cost-effective way. To do this, it is being encouraged to use shared working spaces, to use cloud technology in these spaces to save money, to improve collaboration and to also make sure that staff have the resources available to "work smarter".

Some of the solutions that are being worked towards will be solved by shared services. The shared services are as follows:

- Shared Wi-fi;
- Shared Wide area network (WAN);
- Shared printing and;
- Shared meeting rooms, using a booking system available to all tenants.

One of the core programmes run by the GPU is the Government Hubs Programme, which is making inno-

ventions to the central government's estate by accommodating staff in shared regional hubs and supporting office estates, hoping to transform the Civil Service. The Government Hubs Programme transferred to the Shadow GPA in January 2017 and aims for a radical reshaping of the civil service estate. The key benefit of the Government Hubs Programme concerns their strategic locations, boasting excellent public transport connectivity and local amenities for staff. Striving to encourage flexible working with collaboration zones, these will ensure that staff working in cross-department projects can sit and work together.

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**"Smart working focuses on how to make the most of today's advances in IT and technology, enabling a more flexible use of premises. This approach aims to deliver the benefits of better decision-making, faster communications and greater collaboration across boundaries."**

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There will also be quiet and private zones for work done by government staff that is confidential or sensitive. Furthermore, Cloud-based technology (which is a high priority) will free staff from their desks to work in the zones that are better suited to getting their job done.

The Government Hubs Programme will reduce the government estate from around 800 to 200 buildings by 2023, saving approximately £2.4 billion over 10 years. These spaces will support new and developing ways of working, allowing staff to work from a variety of locations, including hubs.

Smart working focuses on how to make the most of today's advances in IT and technology, enabling a more flexible use of premises. This approach aims to deliver the benefits of better decision-making, faster communications and greater collaboration across boundaries.



John Manzoni, Chief Executive of the Civil Service and Cabinet Office Permanent Secretary stated in December 2016, that: "I'm proud to say that the Civil Service is also embracing these changes, becoming more efficient and effective in its approach to working cultures and the environment in which it works". It is clear to see that progress, an open mind, and the decision to embrace this new method of working will heavily contribute to: "A brilliant civil service".<sup>1</sup>

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**"The Government Hubs Programme will reduce the government estate from around 800 to 200 buildings by 2023, saving approximately £2.4 billion over 10 years. These spaces will support new and developing ways of working, allowing staff to work from a variety of locations, including hubs."**

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An individual worth a mention is Smarter Working Programme Director at the Home Office, Martin Sellar, a seasoned PPM professional tasked with delivering some significant change initiatives across several

government departments. Martin is focussed on the governance and delivery of projects to cost, time and quality, indeed he is working with stakeholders to bring issues forward effectively in operating environments that are complex. In his current role, Martin is concerned with rolling out the cultural move towards smarter working in the Home Office for the 30,000 staff there, while also reducing estates costs and increasing productivity by 10%.

At a conference (Assets & Estates Management Conference) recently, Martin revealed his thoughts on enabling smarter working by means of greater staff flexibility and modern working technology. He also discussed the importance of working closely with managers, staff and senior sponsors to bring forward the Smarter Working Programme (SWP).<sup>2</sup>

On the UK government's website, we find out that the Home Office's Smarter Working Programme (SWP) led the design of a groundbreaking new office building in



Manchester. Indeed, the building design made smarter working possible, “by offering staff flexibility in their working arrangements and equipping them with modern technology.”<sup>3</sup>

On the website of the Civil Service’s TW3 Awards, we find out about the prestigious 2017 The Way We Work Award for Leadership. This Manchester based project certainly embraced the concept of forward-looking change, as we find out on their website: “Staff surveys have measured increased staff satisfaction, motivation and engagement, and business areas continue to promote smarter working to attract new talent and retain its experienced staff. The SWP established a network of skilled smarter working champions to drive cultural change across the business and offer support at the team level. As a result, better collaborative working between HO business areas, suppliers and customers is helping the HO achieve better outcomes.”<sup>4</sup>

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**“Overall, the government in the UK is working towards developing new ways of “smarter work”, collaborating with new technology and sharing ideas on how to go about this, be it via a new programme or simply via social media platforms. The GPU, for example, will continue to develop their core programmes for a smarter and more efficient workplace.”**

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Another initiative worth underlining is “Work Wise Week”, which took place from 14th – 20th May 2017, with National Work from Home Day on the 19th of the same month.<sup>5</sup> The aim of Work Wise Week and National Work from Home Day was to promote modern “smarter” working practices, such as agile, flexible, remote and mobile working, as well as working from home. It aims to show the simplicity of smarter working in all types of business and how much of a difference can be made within the public sector if everybody got involved to help achieve a more productive United Kingdom.

Work Wise Week creates the space for us to think about the issues within any business and it encourages us to pose certain questions. What are the key drivers of your business? How productive is your organisation? Are you achieving more output per hour? Are you measuring the right things? Have you created the right culture for success? Without a doubt, these are difficult

questions to ask and even more hard to answer without some real investment in time, research and people themselves.

This initiative also aims to give staff in government the time to think about these questions, thus encouraging them to pause and think about how they can work efficiently. The end goal is to reach successful new approaches, which will essentially result in effective change for the future.

Overall, the government in the UK is working towards developing new ways of “smarter work”, collaborating with new technology and sharing ideas on how to go about this, be it via a new programme or simply via social media platforms. The GPU, for example, will continue to develop their core programmes for a smarter and more efficient workplace. ■

1 <https://civilservice.blog.gov.uk/2016/12/21/changing-the-way-we-work/>

2 <https://assetmanagement-conference.co.uk/speakers/martin-sellar/>

3 <https://www.gov.uk/government/news/government-departments-celebrate-being-at-the-forefront-of-smart-working-revolution>

4 <http://www.tw3awards.com/page/2017-winners>

5 <https://www.workwiseuk.org/>

### MF Warrender

#### Writer

Open Access Government

[editorial@adjacentopenaccess.org](mailto:editorial@adjacentopenaccess.org)

[www.adjacentopenaccess.org](http://www.adjacentopenaccess.org)

[www.twitter.com/OpenAccessGov](https://www.twitter.com/OpenAccessGov)



# Supporting cross-public sector working – One Public Estate

In this joint feature from the Government Property Unit and the Local Government Association, we find out more about the delivery of The One Public Estate (OPE) programme that supports cross-public sector working

The One Public Estate (OPE) programme is jointly delivered by the Cabinet Office Government Property Unit (GPU) and the Local Government Association (LGA). It supports cross-public sector working to deliver ambitious property-led projects that create local economic growth, integrate public services and drive efficiency savings. At its heart, it's about local and central government working together with other public bodies to transform communities and local public services and deliver value for money for the taxpayer.

The programme is playing a critical role in supporting engagement between central government departments and councils to unlock land for new homes, support economic growth, deliver efficiency savings to reinvest in frontline services and bring services together under one roof. OPE is about supporting national and local partners to take a place-based approach to improve outcomes.

The programme launched in 2013 with 12 pilot council areas. Each area received seed funding and support from the One Public Estate team to establish a series of projects where joint working across the public sector would enable partners to deliver better outcomes. After 18 months of establishing working practice and demonstrating what this new way of working could achieve, the UK government announced £31 million funding over two years in the Autumn Statement 2015.

This funding allowed the programme to rapidly expand in both its scale and ambition. December saw the latest cohort of new and existing partnerships successfully bidding for funding and support. The programme we see today is of national significance, involving 319

councils in England (more than 90%) working in 76 partnerships.

We are already seeing the benefits of the hard work by partnerships as part of early pilot phases of the programme. To date, early OPE projects have raised £70 million in capital receipts, cut running costs by £20 million, created 5,700 new jobs and released land for more than 1,300 new homes. This is over and above what they would have delivered without OPE partnership working.

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**“To date, the programme has supported more than 400 projects across England, delivered in partnership with a wide range of public bodies. By 2020, established OPE partnerships are set to create 44,000 jobs, unlock land for 25,000 homes, raise £615 million in capital receipts from sales and cut running costs by £158 million.”**

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A key strength of the programme is its flexibility. Whilst partnerships are encouraged to use public land and property to meet One Public Estate objectives, they are supported to do so in a way that meets local priorities. For example, in Cornwall - one of the country's most rural areas - partners are using OPE to work in partnership to deliver 10 integrated public service hubs in key areas across the county.

These hubs will bring a range of public bodies including the council, health, Job Centre Plus and emergency services together under one roof. A great early success in Cornwall has been the development of a blue-light service centre in Hayle and the country's first Tri-blue-light services officer - a trained paramedic, police and fire officer. As well as improving services for communities,

the hubs proposals expect to raise over £3 million in capital receipts, save organisations £2 million in running costs and release land for 480 homes by 2020.

OPE support is also a key part of delivering national estate transformation programmes. For example, the Ministry of Defence Better (MoD) Defence Estate Strategy 2016 set out plans to reduce the size of the built estate by a third by 2040. OPE is supporting joint working between MoD and a number of councils across the country to release surplus MoD land for new homes. The NHS Five Year Forward View sets out plans to move health services to the community where possible and to continue to better integrate health and social care services. OPE is supporting health partners, councils and others to bring related services together under one roof, improving public access and better integrating services. The Department for Work and Pensions (DWP) is reforming the benefits system. OPE is supporting DWP to co-locate employment services with council benefits services offering a simpler route to accessing public services.

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**“The One Public Estate (OPE) programme is jointly delivered by the Cabinet Office Government Property Unit (GPU) and the Local Government Association (LGA). It supports cross-public sector working to deliver ambitious property-led projects that create local economic growth, integrate public services and drive efficiency savings.”**

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A core objective of OPE is to unlock public sector land for new homes. The Bedford and Central Bedfordshire OPE partnership are using the programme to release public land in Bedford town centre. High demand for new homes has seen Bedford Borough Council take a proactive role in bringing land to the housing market. Through the programme, partners have identified a number of publically owned sites across the town centre including surplus council and NHS land, a Magistrates Court and Network Rail land which may be suitable for redevelopment. OPE support and funding is being used to masterplan the area and undertakes works to prepare sites for redevelopment. Early wins have seen the police move from the town centre police station into the council's offices. Not only has this move enabled the police station to be released for

redevelopment, it has also enabled the police and council's neighbourhood teams to work together to improve community services. Overall, 15 sites in the town have been identified by public partners for release, set to unlock land for over 1,000 new homes by 2020.

The programme offers partnerships funding and practical support. OPE has a joint team from the Government Property Unit in Cabinet Office and the Local Government Association. We have regionally-based staff who work closely with partnerships across the country, as well as a central programme team largely based in Whitehall. The team provide access to UK government decision makers and plays a brokering role between partners where needed, to unlock barriers to delivery. We also provide support to establish strong local governance arrangements, local leadership and project management needed to deliver projects locally.

To date, the programme has supported more than 400 projects across England, delivered in partnership with a wide range of public bodies. By 2020, established OPE partnerships are set to create 44,000 jobs, unlock land for 25,000 homes, raise £615 million in capital receipts from sales and cut running costs by £158 million. ■

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### **Angela Harrowing**

#### **Deputy Director, Asset Efficiency and One Public Estate**

Government Property Unit, Cabinet Office

[gpusecretariat@cabinetoffice.gov.uk](mailto:gpusecretariat@cabinetoffice.gov.uk)

[www.gov.uk/government/groups/government-property-unit-gpu](http://www.gov.uk/government/groups/government-property-unit-gpu)

<https://twitter.com/ukgovproperty?lang=en&lang=en>

### **Brian Reynolds**

#### **Director, One Public Estate**

Local Government Association

Tel: +44 (0)20 7664 3000

[info@local.gov.uk](mailto:info@local.gov.uk)

[www.local.gov.uk](http://www.local.gov.uk)

[www.twitter.com/LGAcomms](https://www.twitter.com/LGAcomms)

# Maximising the potential of your empty property portfolio

Stuart Woolgar, CEO of Global Guardians, discusses the implications and opportunities of the shrinking public sector estate

**T**he public-sector estate is shrinking as both the Government Property Unit (GPU), in tandem with municipal and other authorities, seeks to utilise property assets more efficiently and effectively.

The way we work as a nation is changing, especially in offices. We can now work remotely or from home or do flexible hours that better suit our employers or personal lifestyles; offices are changing with hot desking more common as cloud-based technologies and smarter cities enable a different style of working, even in the public sector.

The government's aim is to deliver this smarter way of working throughout its establishment and the GPU has introduced its Hubs Programme with a target to reduce the government estate from around 800 buildings to 200 by 2023 through the creation of regional 'hubs' and co-ordinated offices. This programme is expected to save approximately £2.4 billion over 10 years and the 'One Public Estate' strategy aims to bring together all the public bodies within a region to look at how their assets can be better utilised to meet this efficiency and cost-saving objective.

In addition to this, the Government Property Agency was set up in



*A former office building has easily been converted by Global Guardians to provide light and airy living spaces for a large group of key inner-city workers*

September to manage the government's portfolio of buildings with a far more commercial focus. As assets are vacated and the portfolio contracts, it will leave a growing number of properties sitting empty until they are re-let, sold or redeveloped.

## The vacant property problem

However, empty buildings can be a magnet for trouble: anti-social behaviour, metal theft, vandalism, squatting, graffiti, fly-tipping... the list is long.

Even though the squatting laws were changed in England in 2012 to cover residential buildings, commercial buildings are different and are still a target. In 2010, the government estimated there were 20,000 squatters at any one time. Since then, other estimates have it anywhere between 20-50,000, with the largest numbers in London and the south-east.

The lack of definitive information on squatter numbers has made assessing

the impact of criminalisation difficult but there is now some anecdotal information which suggests that squatting in commercial premises has increased as a direct result of the introduction of Section 144 of the Legal Aid, Sentencing and Punishment of Offenders Act 2012.

Fly-tipping is the latest menace on the rise. Current figures show there were 1,002,000 cases of fly-tipping handled by councils in England between April 2016 and March 2017, equivalent to 114 every hour, 66,000 (7%) more than the previous year. It cost taxpayers £58 million to clear up and was the fourth year in a row that incidents increased<sup>1</sup>; since these figures don't include private removal of illegally dumped waste the total is probably considerably higher.

Even if they are no longer active as a working centre, vacant buildings are still a drain on financial resources: insurance, rates and security must be

paid for. The option of secure fencing, shutters and boarding around a site merely attracts disfiguring graffiti and doesn't keep out anti-social behaviour, nor determined thieves after, e.g., copper piping and wiring, fireplaces, or anything with a scrap value. Vacant premises also deteriorate rapidly, and this can cover everything from vermin infestation to leaking roofs, blocked guttering and frost damage.

Overriding all of this is the cost of business rates and insurance which still must be paid. These items can vary considerably depending on if there are people in situ in the property caretaking it, or if it is completely uninhabited. Security guards and dogs can't be there 24 hrs a day, the budget for that is simply impractical; if a team of guards is rostered 24/7, costs can run into tens of thousands of pounds per month.

The local community, therefore, hates empty buildings and see them as a blight on their neighbourhood as they often stand vacant for years with negative PR implications for the owners.

## Housing shortage

Everyone is aware the UK is suffering a housing shortage, especially in the social sector and for first-time buyers trying to get on the housing ladder in some expensive parts of the UK, notably the south and south-east. The country's economy is also somewhat in limbo as the implications of Brexit gradually unravel across both industry and our access to global markets, and inflation is creeping upwards once more. How all this will impact on the property sector is currently unknown to commentators expounding a variety of differing views. In the meantime, there are many people struggling to find affordable homes.

## The Guardian solution

A solution to all the problems associated with vacant buildings is to put guardians in the property through an ethical and responsible company that can turn the void into an income generator, as opposed to a drain, for as long as it takes. The company takes responsibility for the property maintenance and responsible people living on site provide security and deter all the anti-social behaviour and reassure the local community. They also impact positively on the insurance costs and rates. In addition, sometimes the buildings and/or site can be put to further commercial use – everything from a film set, through advertising hoardings to providing off road parking.

Global Guardians are industry leaders, London's largest property guardian company and one of the biggest in the country. We work with government departments, municipal authorities and the NHS, as well as the social housing and private property sectors and have campaigned widely to raise standards in the industry. We are currently working on behalf of the sector with the GLA and professional industry bodies, such as the BSIA, to tighten up the regulations and ensure better standards for guardians.

The sometimes negative or misunderstood view of property guardians is now changing. They are not irresponsible students, potential squatters or illegal immigrants. They are carefully vetted working professionals who care about the properties they live in and keep secure for our clients (owners of vacant buildings). In return, they pay a licence fee to live in the building which is much lower than the equivalent market rate for a rented apartment or house.

The social benefits of using property guardians reflect positively on the

building owners/managers as property guardianship provides much needed affordable accommodation for working professionals looking to save on living costs, especially in expensive city locations like London. Property guardianship can enable some key workers to live near their inner-city workplaces, such as schools and hospitals, and is a real contribution to the provision of social/affordable housing.

Due to the semi-permanent nature of the accommodation, property guardians should necessarily only be single people or couples without children, but for this section of the workforce, guardianship can enable them to save for a house or flat deposit or provide them with more disposable income to finance living costs, hobbies, entertainment and social activities, travel or to run a car. It is win/win for everyone involved in the process and an ideal solution for consideration by property asset managers.

<sup>1</sup> <http://www.bbc.co.uk/news/uk-england-41664941>



**Stuart Woolgar**  
CEO

Global Guardians Management Ltd

Tel: +44 (0)7841 913954

+44 (0)20 3818 9137

[stuart.woolgar@global-guardians.co.uk](mailto:stuart.woolgar@global-guardians.co.uk)

[www.global-guardians.co.uk](http://www.global-guardians.co.uk)

[www.twitter.com/guardians100](https://twitter.com/guardians100)



# Managing an integrated government estate: Lessons from the UK

Paul Wright-Anderson from the National Audit Office sheds light on the revolution that central government property in the UK is experiencing

Central government property in the UK is undergoing a revolution, with regional “Hubs” being established across the country and more integrated management of public sector estate introduced. There are potentially big benefits, but there are significant challenges to be addressed first.

The UK National Audit Office (NAO) is independent of government and reports directly to Parliament on the efficiency and effectiveness of government spending. In 2017, we reported on the progress made government Estate strategy, having previously examined the topic in 2006 and 2012, so we are therefore well placed to assess the changes over time.

In 2014, the Cabinet Office’s Government Property Unit (GPU) published an ambitious Estate strategy to use government office space much more efficiently. Subsequently, government launched the “Hubs” programme, in which large numbers of departments’ staff will be moved into between 18 and 22 regional centres. Outside these main hubs, departments will increasingly share offices with the wider public sector (“One Public Estate”). Leases have already been signed for a number of locations including Canary Wharf, Bristol, Croydon and Edinburgh.

The GPU is also setting up a new Government Property Agency to own and manage centrally offices and other types of property. The GPU believes that the Hubs programme will help central government save around £1.8 billion over the next 20 years. The new buildings will be more efficient and are designed to provide only six square metres per person at full capacity. Hubs will also give greater flexibility for organisations: sharing offices allows better working within and between organisations, and allows public bodies to increase or decrease the size of their office space without breaking

long commercial leases. The programme is intended to improve civil servants’ career prospects, by making it easier to move between organisations without relocating, and make it easier for public sector bodies to attract the skills they need.

In April 2017, the NAO review team I led found that departments had individually made good progress in reducing the size of their estates since 2012 and produced large savings on running costs. But less progress had been made towards achieving a more shared, flexible and integrated government estate. And there were some similarities with other recent government attempts to implement shared services in HR, finance and procurement, which failed because too many stakeholders saw it as against their interest to make them work.

The Hubs programme is all about organisations sharing and collaborating, so ensuring departments’ full engagement is essential. There have been some successes. Since 2012, the GPU has launched significant initiatives to improve working together, alignment of interests and promote best practice, including The Way We Work to help departments create more agile ways of working. And some clusters have been formed, combining estate teams and sharing buildings across organisations.

Nevertheless, there are uncertainties for the government’s Estates strategy at present:

- Most departments’ transformation and workforce plans are at their early stages, making it difficult to estimate costs and savings.
- The scale of property savings is uncertain, some strategic hubs may cost more than their existing

## Planned locations of government strategic hubs



locations, particularly where staff aren't currently based in central London.

- It is not certain that the new strategic hubs will be able to reduce the average space per person to the Estate Strategy's target of six square metres per person; doing so will require a substantial increase in flexible working arrangements, such as working from home.
- With many departments not yet in a position to plan for regional Hubs, it is difficult for the GPU to create a realistic time frame for their creation.

By December 2016, only HMRC and four other departments had committed to leasing significant space in any of the strategic hubs. Given that the central timetable doesn't necessarily align well with individual departments' plans, it's not surprising that many departments had not by that time committed to the programme. Since then, the GPU reports that it has received sufficient commitments from departments to be able to sign leases for buildings in nine Hubs.

As a result, we recommended that the GPU should take stock and, if necessary, delay, redesign or consider phasing its major programmes over a longer timescale, and that it consider adopting a more gradual approach to introducing centralised management.

About the author: Paul Wright-Anderson is an Audit Manager who has produced many cross-government and other VFM studies over the last 20 years, including the 'Progress on the government Estate strategy' report in April 2017. ■

### **Paul Wright-Anderson** **Audit Manager**

National Audit Office

Tel: +44 (0)20 7798 7264

<https://www.nao.org.uk/>

[www.twitter.com/NAOorguk](https://twitter.com/NAOorguk)

# The rationalisation of the UK public sector's extensive office estate

Alison White, co-founder of PLACEmaking details her perspective on the rationalisation of the nationwide public sector's extensive and expensive office estate

Whilst the UK's Government Property Agency (GPA) focuses on centralising ownership of the government estate and, by charging market value rents to departments applying downward pressure to reduce the estate from 800 to under 200 by 2023, the wider remit of the Government Property Unit (GPU) is to ensure all public bodies make better use of a reduced real estate property assets. Whilst focusing initially on the extensive central London office estate, few public-sector bodies are isolated now from the pressures being applied: do better, do more and at significantly less cost.

Rationalisation of the nationwide public sector's extensive and expensive office estate is a hot topic and property teams are energised that finally, the real costs associated with operating, servicing and maintaining an inefficient property portfolio are at last being scrutinised at a senior management level.

## Is office rationalisation enough?

With rationalisation, therefore, being regarded as an attractive source of both capital and revenue savings, the challenge is deciding what to get rid of and what to hold on to. Making that decision is not as simple as in the past when simple exiting leases or selling freeholds would do. It's now made more difficult by the demands of



*Interactive 3D video of Cash Hall.*

*If you wish to view this 360 degree image on your desktop or laptop computer, please use one of the following compatible browser options: Chrome, Firefox, MS Edge, and Opera, moving the image around using your cursor or track pad.*

modern ways of working that challenge traditional assumptions of what we want from office buildings of today and how a key characteristic is how adaptable the workspace needs to be to absorb continuous change and workstyle evolutions.

The increased functionality and reduced costs of mobile technology and telephony, as well as more secure and reliable remote access to digitally generated and stored information, has enabled greater numbers of people to adopt smarter ways of working. Social expectations and wider exposure to global aesthetic influences have increased expectations on the style of a working environment, a greater focus on the negative health and well-

being impact of sedentary work styles plus reduced acceptance of formal office protocols all contribute to a demand for more choice about when, where and how we work.

The consequence of all of this is that we don't just need the same old office solution, but less of it. Indeed, with a better understanding of what smart working really means and what tangible benefits can be realised, the common numerical assumptions of property professionals to determine the scale of a retained estate and the assumption that glass and steel open plan offices are still the preferred solutions ignores that fact that revolutionary change has happened and as such, a fresh approach is demanded.

A recent case study, the 2017 TW3 award-winning Bristol City Council project is regarded by the UK Cabinet Office as an exemplary project for local government: reducing the office estate by 85%, increasing utilisation of the retained estate by 250% as well as delivering £125 million savings over five years. It ticked all those boxes. But it did more. The retained estate included a Grade 2\* heritage building that was refurbished and remodelled with English Heritage approval, reflecting changes of the council's way of working.

Overall the reduced estate has achieved the target of 5 sqm per person. Now only 30% of the workspace includes traditional desks, with the remaining 70% including multiple innovative, collaborative and interactive work settings solutions reflecting the adoption of smart working across the council. Reducing the proportion of the building to private workspace has increased the proportion of the building access by the public – and increasing income generation opportunities has increased use of the building beyond normal corporate hours and provides a valuable community asset to the city of Bristol.

## So, what does optimising office space mean?

Optimising a reduced office estate demands a re-rethink of the purpose of the office and a change of expectations by building both providers and users. Users need to reappraise what they expect to personally 'own', instead focusing on what sort of experiences they want when using the office. They need to consider space as a shared commodity used by them sometimes frequently but more often sporadically. Building providers need

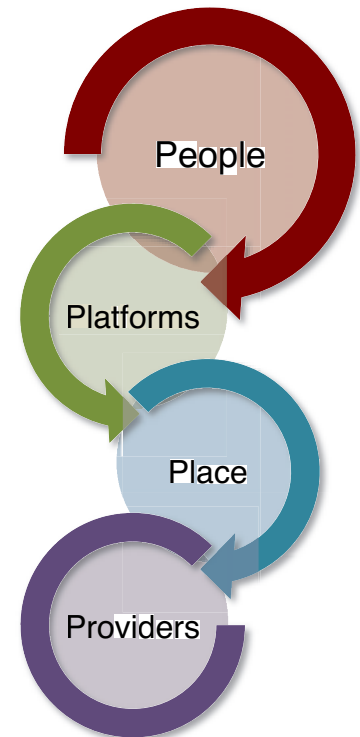
to rethink their attitudes towards building users, from them being static occupiers to being temporary consumers of space, facilities and services.

Building owners need to provide better quality assets and solutions that directly support their customers own productivity, which in turn, increases the desirability and value of space. When most office buildings sit idle for 40% of the time they are officially open for use, so facilities managers need to rethink how space is operated, focusing on design solutions that motivate and delight people, not just what minimises operating costs and asserts operational control.

We may need to rationalise the total volume of office space, but what we hold on to needs to be used more efficiently and effectively. Otherwise, those people now allocated with mobile telephony and technology devices will simply find better and more attractive places to work and as such, the value of social interaction will be lost.

## How do we rationalise and optimise space?

There have been several attempts to describe the changes in the way we work and the design of rationalised and optimised workplaces. New ways of working, flexible working, agile working and the GPU's own The Way We Work (TW3) to name but a few. Smart working though has emerged as an accepted term, as it refers to the adoption of modern working practices and the key constituents of the transformational programme of change that together enables optimisation and rationalisation to be achieved and successfully sustained.



PLACEmaking supports our clients by delivering smart working solutions. Our expertise is in addressing the four key elements of change:

**PEOPLE** – transforming working practices and attitudes to how space, facilities and assets are used and provided;

**PLATFORMS** – maximising the use of technology, access and use of digital information;

**PLACE** – providing efficient and economically viable workplaces that support users changing requirement and;

**PROVIDERS** – repurposing customer focused support services to better meet users' requirements.

PLACEmaking expertise and skills enable us to deliver end-to-end professional



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services, developed to support our clients achieve their change objectives, including:

- Workplace change, communications & engagement;
- Interior architecture & design;
- Strategic asset management;
- Digital and technology advisory and;
- Programme management.

PLACEmaking's change management approach is scalable to suit our clients' workforce headcount, a recent project included over 7,000 users. With a toolbox of over 135 change tools and methods, we implement our change management plans either via internet online, internal intranet communica-

tions networks or through structured face to face interactions. Our tried and tested approach is a four-step transformational programme of change, profiled engagement and communications, sequentially supporting people through;

### Pre-implementation

- 1. Raising awareness** – relating the organisational programme objectives with personal self-navigated change journey;
- 2. Familiarisation** – enabling people to relate to the proposed new space, facilities, assets and operational support service;
- 3. Preparation** – pre-implementation induction, minimising operational disruption and maximising desired business benefits.

### Post-implementation

- 4. Aftercare** – measuring results and ensuring desired objectives are achieved, reported and acknowledged.

Now is the time to update and upgrade expectations about the workplace, how it operates and how we productively function in it. If more than 30% of your office space has desks in it, or meeting rooms are the only alternative spaces available to get away from the desk, then it's time to review how your workplace is holding you back from achieving your future vision and business expectations.

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## PLACEmaking

**Alison White**

**Co-founder**

PLACEmaking

[www.placemaking.co.uk](http://www.placemaking.co.uk)

[www.twitter.com/PLACEmaking\\_uk](https://www.twitter.com/PLACEmaking_uk)



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# Progressive change ahead in public services

Paul Bradbury, Group business development director at Civica, shares his reflections on the future of delivery in public services leading up to 2025

Local government is well aware that the transformation to meet “new” digital world demands is key. It’s an issue we’ve explored in depth in Civica’s ‘Changing Landscape’ series of reports. And the world is moving fast. Devolution, mergers, commercialisation, shared services, shifting services online and delivering a digital experience for the masses are all affecting the way public services are run today.

Civica brought together former members of the SOLACE Springboard programme to discuss the issues and trends that will affect the way local authorities operate in the lead up to 2025 and beyond. As the industry’s future leaders, understanding their expectations and insights for the future is vital to lifting the lid on what we can expect in the years to come.

The central theme of the discussion focused on what the leaders of today need to do now to enable a successful authority in 2025. The group agreed that two issues needed to be prioritised – broadening the role of the local authority from a community guardian to a commissioner of services and the retention of employee skills and resources, alongside key partnerships.

An interesting point raised in the discussion was the need for a shift from citizens being reliant on local authorities towards an environment where people take responsibility for their own well-being. This will require local authority leaders to move away from a one size fits all approach and implement new strategies that are bespoke to their local communities, such as self-service solutions tailored to individual authority needs. All

agreed that to achieve this, there are four key areas that must be addressed.

### **Citizen disconnect**

Residents continue to feel disenfranchised with local government, leaving authorities locked in a constant battle to shift public opinion. To do so effectively, local authorities need to better inform citizens and ensure the entire community is aware of what changes will be made – and importantly, why.

Citizens don't understand budget cuts – they do not realise that investment is being made to commercialise services and realise efficiencies to plug funding gaps. Malcolm Bennie, Strategic Lead for Communications, Culture and Communities at West Dunbartonshire Council, summed up the sentiment perfectly by stating that residents: "feel that things are done to them rather than with them".

Key to addressing this will be keeping citizens informed on the steps and measures each local authority is making to benefit them. All agreed that with community support, changes can be implemented more quickly and successfully, and authorities can become more agile.

### **Data analytics**

Today's citizens are demanding a faster, data driven and more accurate service from local authorities. To deliver against these expectations, authorities need to be at the forefront of technology and predictive analytics, using the latest techniques to not just improve their understanding of citizens but also help them to live their lives better. To realise this potential, the leaders of today need to address widespread infrastructure and data quality issues. Only then can new technology and data analytics be deployed to help improve the lives of the community going forward.

For example, data mining techniques need to be deployed to better understand residents, helping authorities to realise further efficiencies and help ensure targeted interventions are successful.

### **Workforce empowerment**

To meet growing financial and service pressures, changes need to be made in terms of internal company culture. As Sanjay Mackintosh, Head of Strategic Com-

missioning at Haringey Council, said: "The organisation of 2025, which is likely to be much smaller than it is now, needs to have everybody at every level taking some degree of risk in how they operate."

The Forum agreed that today's leaders need to foster an environment that encourages risk taking. If there is an acceptance that there will be failures along the way – with a process in place to deal with those failures and to learn from them – ultimately the pace of change and delivery of improvements will accelerate.

Crucially, local authority employees must also have the skills to take responsibility and the confidence to positively engage with residents, businesses and customers. For collaboration with citizens to work, authorities need the right people, with the right skills and network to establish better engagement across the entire landscape.

### **Create effective partnerships**

Authorities need to break down organisational barriers across departments and work together collectively. And this collaboration needs to start internally. To realise significant economies of scale, local authorities need to become information and knowledge partners as well as joint commissioners.

Outside of this, the Forum participants agreed that collaboration with third parties, including those in the private sector, will also be crucial to meeting citizen needs. The priority has to be collaboration which will not only help to improve services but also support long-term efficiencies.

With so much change to come – alongside continued uncertainty – 2018 will no doubt be challenging, but the years ahead pose an exciting opportunity to radically re-think the way organisations operate. ■

### **Paul Bradbury**

#### **Group business development director**

Civica

Tel: +44 (0)113 244 1404

[www.civica.com/en-GB/](http://www.civica.com/en-GB/)

[www.twitter.com/CivicaUK](https://www.twitter.com/CivicaUK)



# Europe beyond the seas: The Outermost Regions

Commissioner for Regional Policy, Corina Crețu details The Outermost Regions strategy of the EU

**T**he EU has always paid particular attention to its nine Outermost regions, which are first and foremost European regions. This Commission went a step further so as to give these European lands from all around the globe a stronger voice, in the context of a privileged partnership between them, their respective Member States and the European Commission.

For many years the EU has acknowledged the specific features common to the Azores, the Canary Islands, Guadeloupe, French Guiana, Madeira, Martinique, Mayotte, Réunion and Saint Martin, and has afforded them a special status. These regions are indeed subject to constraints that hamper their economic development: remoteness and/or insularity, small size, vulnerability to the consequences of climate change and dependence on some local productions which have not integrated innovative processes yet.

This is why, in October 2017, we proposed a renewed strategy to boost growth and help these regions create more opportunities for their inhabitants.

For the first time, the Commission is working with the Member States to provide tailored support to each of these regions and help them build on their own and unique assets – an extraordinary biodiversity, a geographical position conducive to international exchange and cooperation and endless opportunities in areas such as blue growth or space science.

In order to better reflect these regions' realities and interests in EU policies, a platform for dialogue will bring together the regions and their Member States, the European institutions and private stakeholders, who will meet to exchange views during the legislative process. The Commission will also establish, upon request, special working groups on certain issues, such



*Corina Crețu, Commissioner for Regional Policy*

as tackling unemployment or making the best use of EU funds.

Promoting regional cooperation and deepening relations between the outermost regions, neighbouring countries and regional organisations is also a key pillar of the European Commission's renewed strategy for the outermost regions. The Commission will promote political dialogue and the setting up of joint projects between the outermost regions and their neighbours.

Making use of the smart specialisation model, which has proved its worth, the strategy seeks to help the regions to build on their assets, supporting greater innovation in traditional sectors such as fisheries and agri-food. To that end, the Commission will propose to continue the Programmes of Options Specifically Relating to Remoteness and Insularity (POSEI) after 2020 and will assess whether State aid can be used to support the renewal of small-scale fishing fleets.

Access to finance for the regions' economic growth will be facilitated by dedicated support from the European Investment Bank, in collaboration with national and regional financial institutions and with the help of EU funds, which invest over €13 billion in the nine regions over the 2014-2020 funding period. A new initiative will

be created under the Investment Plan for Europe, also called the Juncker Plan, with the aim of facilitating regions' access to the European fund for strategic investments (EFSI).

Because youth unemployment is one of the major challenges these regions face, the EU will give young people from the Outermost regions a financial boost to enable more of them to participate in the Erasmus programme and in the European Solidarity Corps, in order to promote mobility and the acquisition of new skills for the future.

The Commission will carefully follow up the implementation of this strategy and will help all outermost regions, European lands beyond the seas, make the best use of available EU instruments and investments, for the direct benefit of their inhabitants. ■

**Corina Crețu**  
**Commissioner for Regional Policy**

European Commission

[corina-cretu-contact@ec.europa.eu](mailto:corina-cretu-contact@ec.europa.eu)

[https://ec.europa.eu/commission/commissioners/2014-2019/cretu\\_en](https://ec.europa.eu/commission/commissioners/2014-2019/cretu_en)

[www.twitter.com/CorinaCretuEU](https://www.twitter.com/CorinaCretuEU)

# A sustainable future for cities is within our grasp

Abdeluheh Choho, deputy mayor of Amsterdam and chair of EUROCITIES Environment Forum shares his thoughts on the sustainable future for European cities

**A**s European cities, we are committed to making the transition to a circular economy. Building a more sustainable economy is an urgent environmental necessity and vital to our efforts to future-proof our cities and improve people's quality of life.

The circular economy encourages the reuse, repair and redesign, rather than disposal of materials and is set to provide new and sustainable competitive advantages for Europe.

As the level of government closest to citizens, we see that our societies are already on the path towards a circular transition through citizen and community-based commitments and initiatives. We have a responsibility to facilitate and accelerate this transition, while ensuring that opportunities generate benefits for citizens, leaving no one behind.

Amsterdam's ambition is to become a frontrunner in this transition and we were the first city to commission in-depth research into the potential of the circular economy. This led to the creation of Amsterdam's integrated strategy and the dedicated programme, 'learning by doing'. For example, Amsterdam integrated the principles of circularity from the start in the urban planning strategy of the cities' largest transformation area 'Harbor – City' with 70,000 houses.

Other cities are following this model and the recent EUROCITIES conference, which took place in Ljubljana, focussed on the crucial role cities play in boosting this transition, marking a real step up for cities' engagement.

## Local inspiration

The circular economy will lead to changes in the value we place on product lifecycles, with implications for jobs and skills. Moreover, work streams related to

product design, repair, reuse and recycling which are all labour intensive will become more prominent.

Brighton & Hove recently hired a 'reuse manager' to work on a modernisation programme that changed the way the council thinks about its offices, assets and approach to work. The King's House project, which involved emptying the largest office block in the city of 1,000 staff along with all their furniture and equipment, was used to benefit residents, organisations and community groups. In total, 150 tonnes of materials were reused, which is equal to £150,000 of economic value re-entering the local community.

As facilitators of collaboration and matchmakers, cities are well placed to involve all sectors of society – citizens, civil society, entrepreneurs, businesses, financial institutions, all strands and levels of government in the circular transition.

Gothenburg's smart map is a digital map based on the participation of local inhabitants and a public partnership. Developed in 2016, it promotes a sustainable lifestyle by encouraging citizens to find alternatives to consumption, such as sharing or lending. Through several public 'map jam events' local initiatives helped to give shape to the project, which now shows around 100 organisations. It is a continuously evolving map, to which any citizen or organisation can propose new initiatives.

As buyers of public goods and services, cities can lead by example, using our public purchasing power in full support of a resource efficient, environmentally friendly, circular transition.

Dusseldorf's city administration consumes about 40 million sheets of office paper annually. With this in



**Abdeluheh Choho**

Driving investment in jobs and skills will create a workforce ready to embrace the circular economy in Europe and promoting sustainable business models will mean considering the whole value chain.

The European Commission and member states should also do more to help facilitate the creation of a market for secondary raw materials, developing a level playing field between virgin material and the reuse of treated material. Developing common indicators of the circular economy, which are agreed by all stakeholders, would also help to create standards and speed up progress.

As cities, we are ready to work with all partners, including through the urban agenda partnership on circular economy, business organisations, the EU institutions, member states and the circular economy stakeholder platform to support policy and programme developments at EU level from a city perspective.

Together we can work towards success. Together we will build a sustainable future.

EUROCITIES is the network of major European cities, with over 140 members, representing more than 130 million people. ■

mind and with a primary aim of stimulating demand and ensuring a price reduction for recycled paper, the administration started procuring recycled paper for its office needs. This now accounts for 85% of the city's paper use.

As urban planners' cities can trigger new integrated approaches that reduce pressure on urban resources while providing economic growth and social opportunities.

Oslo has been developing a waste management system based on circular principles to ensure separate waste collection is maximised and transform waste into secondary raw materials. To do so it has actively engaged with citizens, farmers as well as with its city's public transportation company. For example, Oslo transforms food waste into biogas, which is used as fuel by buses and garbage collection trucks in the city. Find out more about Oslo's circular economy best practice.

### **Working together towards success**

The EUROCITIES conference was a good opportunity for cities to share experiences and learning with other cities to jointly build capacity and speed up the transition towards circular cities. We shared many case studies publicly, through the EUROCITIES Awards and agreed on other key points going forwards.

To maximise the potential benefits of a circular economy, we need EU leadership, backing our efforts at the city level and setting a strong enabling framework. This will include reviewing EU current and forthcoming legislation from the perspective of removing possible barriers to accelerating the circular economy.



**Abdeluheh Choho**  
**Deputy mayor of Amsterdam and chair**  
**of EUROCITIES Environment Forum**

EUROCITIES

Tel: +32 2 552 08 88

[info@eurocities.eu](mailto:info@eurocities.eu)

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



# Opportunities for social cohesion in diverse and deprived neighbourhoods

Dr. Anouk Tersteeg and Dr. Gideon Bolt from Utrecht University explore the opportunities ahead for social cohesion in diverse and deprived neighbourhoods

Political debates about diversity in Europe are still mostly concerned with the question of how much diversity to accept, whereas the reality is that cities are becoming irreversibly more diverse, not only in terms of ethnicity and socioeconomic status of people, but also in terms of for example their identities, activity patterns, lifestyles and household types (Tasan-Kok et al. 2013).

Rather than questioning whether to accept diversity, our field studies in Feijenoord, a deprived and diverse neighbourhood in Rotterdam, invite policy makers to focus on questions of how to accommodate an increasingly diverse urban population. Our study is part of the international DIVERCITIES<sup>1</sup> (Governing Urban Diversity: Creating Social Cohesion, Social Mobility and Economic Performance in Today's Hyper-Diversified Cities) project, undertaken in 14 cities). The following suggestions are based on our analysis of the situation in Rotterdam, but they are of a wider relevance for other European cities.

## **Towards a comprehensive rhetoric of urban diversity**

Focussing on traditional ethnic and socioeconomic categories, problematising cultural diversity and stressing cultural assimilation do not do justice to the emergent highly diverse population of cities. By mostly focusing on the challenges that urban diversity brings, such an approach is not open

to the opportunities that diversity offers for social cohesion. Instead, it contributes to a negative reputation of diverse neighbourhoods. To seize the opportunities of urban diversity, policy makers, other civil servants and urban professionals at all scales should fully embrace urban diversity.

In this sense, much can be learned from the inclusive, open-ended and opportunity-driven approaches of grass-roots initiatives studied in the highly diverse context of Feijenoord in Rotterdam. The grass-roots initiatives have an eye for the multiplicity of skills, knowledge, culture, information and support networks that the local diversity of people brings and see this as a quality. These initiatives bring together diverse people to encourage social cohesion, social mobility and entrepreneurship (see Tersteeg et al. 2014; Tasan-Kok et al. 2017).

Next to this alternative rhetoric of diversity, the grass-roots initiatives offer a rich local network and detailed knowledge about the interests, needs and problems among residents, which provides crucial information when both developing and realising urban policy.

## **Facilitating spaces for exchanges across differences**

Research in Feijenoord in Rotterdam refuted the dominant perception in policy and some academic schools of thoughts that social cohesion levels in

diverse, deprived areas are low. It did so by showing that through locality-based weak ties of neighbours and other local acquaintances residents in Feijenoord are connected on many different dimensions, for example in terms of ethnicity, religion, lifestyle, education, occupation, household type.

The diverse weak ties offer residents information, companionship and social and practical support. This is particularly so for people who are relatively dependent on the neighbourhood for their daily activities and social contacts. For the main part, people with a low socioeconomic position, households with young children and elderly people, profit from these weak ties. Key facilitators of diverse weak ties appear to be shared spaces with neighbours and local facilities and amenities in which people with diverse backgrounds meet recurrently and for sufficient time, to get to know one another, such as schools, community centres and activity spaces of sports clubs.

Nevertheless, over the last decade, the municipal budgets on neighbourhood-based facilities and services for low-income groups, particularly community centres, but also language courses for newcomers have undergone major cuts. At the same time, city governments have increased their budgets for creating attractive cities and neighbourhoods for middle-class households. Budget cuts on local spaces that bring

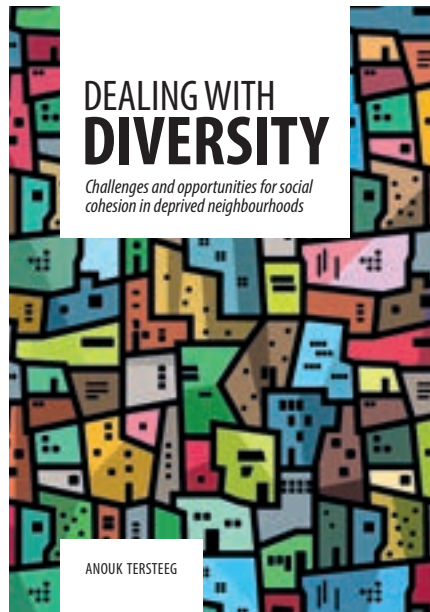
together people with diverse backgrounds counteract social cohesion.

A relatively low-cost way to maintain and facilitate social cohesion is to support public and semi-public neighbourhood spaces in which diverse groups of residents meet. Another way to facilitate social interaction in shared spaces is by offering language courses free of charge. Otherwise especially low-income immigrants will have fewer opportunities to follow such a course. Not being able to speak the same language appears to be a key barrier to positive perceptions of diverse local others and local social interactions and relations across differences.

### Adjusting expectations of the middle-classes

In many other European countries, municipalities and housing corporations have made concerted efforts to attract middle-class residents to deprived urban neighbourhoods, amongst others because their presence is thought to help residents with a lower socioeconomic position here. Yet, our research shows that income groups in mixed-income settings see each other in local public spaces but hardly meet, let alone develop positive relations. This is because they use different neighbourhood spaces. Higher income groups use facilities and services that are hardly accessible to lower income groups and spend less time in the neighbourhood (except for families with young children).

In this sense, one might argue that it is higher income groups who participate poorly in everyday neighbourhood life in diverse, deprived neighbourhoods, rather than lower income groups,



which urban policy often suggests. To counteract segregated social networks along lines of income, one way forward is to facilitate inclusive meeting spaces. Our research indicates that local schools, community centres and sports clubs are already key facilitators of social relations between diverse people, albeit mostly with a low-income. It is in these spaces that policy makers should invest. If local schools, sports clubs and other community services and spaces that are accessible to low-income groups offer a higher quality of products and services, this will also seduce higher income groups to use them.

Highly diverse contexts require inclusive management practices. That is, practices that acknowledge, listen to and accommodate as much as possible the multiplicity of needs of residents, also those of minorities and low-income groups. Neighbourhood professionals (such as civil servants and professionals of housing corporations) can only do this when they move beyond the privileged treatment of (white) middle-class house-

holds. As Tersteeg, Bolt and Van Kempen (2015, p. 60) have argued: maintaining that those (white) middle-class neighbourhoods: "Are the ideal or the norm strongly denies that people with other lifestyles and opportunities are also part of [and important to] a city. It is a discourse that strongly negates the diversity of city life".

<sup>1</sup> This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement No. 319970. SSH.2012.2.2.2-1; Governance of cohesion and diversity in urban contexts.

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**Utrecht University**

**Dr. Anouk Tersteeg**

**Dr. Gideon Bolt**

Faculty of Geosciences

Utrecht University

Tel: +31 30 253 1399

[g.s.bolt@uu.nl](mailto:g.s.bolt@uu.nl)

<https://books.ipkampprinting.nl/thesis/514607-Tersteeg/>





**Utrecht University**



# Challenges and opportunities of living **amidst diversity**

In December 2017 the PhD-thesis *Dealing with Diversity: Challenges and opportunities for social cohesion in deprived neighbourhoods* (Tersteeg, 2017) was published. The main research question of this dissertation was: How do residents of deprived neighbourhoods face the challenges of living among diverse others and how do the residents seize opportunities for positive relations across difference? The study was part of the DIVERCITIES (Governing Urban Diversity: Creating Social Cohesion, Social Mobility and Economic Performance in Today's Hyper-diversified Cities) research project. Fieldwork for this project was undertaken in 11 EU cities: Antwerp, Athens, Budapest, Copenhagen, Leipzig, London, Milan, Paris, Rotterdam, Tallinn, Warsaw; and three non-EU cities: Istanbul, Toronto, and Zurich. In this e-book, we argue that diversification is a process that is not only related to immigration, we go one step further and will use the term hyper-diversity. With this term, we aim to make clear that we should not only look at diversity in ethnic, demographic and socio-economic terms, but also look at the differences that exist with respect to lifestyles, attitudes and activities.

For more information **[CLICK HERE](#)** to read our eBook.



# Smart city strategies from around the world

Rushi Rama from Future Cities Catapult gives a fascinating overview of smart city strategies from around the world

The use of technology is changing everyday life for people in cities and how the city is evolving to meet their needs. This is nothing new, we only need to see how the elevator made possible high-rise buildings, or how cars allowed cities to grow horizontally. But the pervasive nature of digital technology means that this change is impacting people's lives at an unprecedented pace.

The concept of a 'smart city' was popularised as a concept in the early 2010s to describe the use of these new advances in technology and data to make better decisions about governing cities and delivering services. Since then, interest in the concept has exploded, attracting influence, investment and criticism across the world.

The 'smart city' rose to prominence in the public consciousness as a marketing concept from global technology companies that saw an opportunity to sell digital transformation and new technology into big city systems (water, energy, transport). 'Smart City' caught the imagination as smart phones and digital transformation spread across the world at a phenomenal rate.

But while the market opportunity was clear to technology companies, the proposition for cities was less clear-cut and voices from government and academia quickly questioned the value of the solutions coming from these companies from the city and the citizen's perspective. In the space of a few years, the concept of a smart city shifted from a focus on technologies and systems to citizens and services for them.

We are now witnessing a challenge to the vision of a citizen-centred smart city arising from the disruption brought by Silicon Valley companies. Digital transformation is allowing these companies to disrupt existing

ecosystems, offering both challenges and opportunities to citizens and city stakeholders. For the most part, governments have been slow to consider whether their strategies and regulations are fit for purpose in the context of this rapid disruption.

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**"The 'smart city' rose to prominence in the public consciousness as a marketing concept from global technology companies that saw an opportunity to sell digital transformation and new technology into big city systems (water, energy, transport). 'Smart City' caught the imagination as smart phones and digital transformation spread across the world at a phenomenal rate."**

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It is in this context that Future Cities Catapult has embarked on an ambitious research programme to take stock of the rich experience of smart city strategies that are emerging on every continent. In November we launched our first report of our findings from looking at more than 20 cities from around the world. We aimed to give city leaders a quick summary of the issues that leading cities are facing and a set of practical recommendations:

1. Local governments often lack the capacity to understand, develop and implement smart city strategies. An innovation of this kind requires upskilling and support from senior leadership.
2. To ensure that smart city strategies are implemented, they need to be embedded in the statutory frameworks and plans.
3. Many cities have made fast progress through top-down leadership, but for a smart city that is adopted by people and therefore impactful, a collaborative approach is required. This means collaboration with all



key stakeholders (business, government departments, universities) and with citizens.

4. Most smart city funding is still derived from innovation pots and not linked to core city funding. Making this transition will allow scale-up.

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**“The concept of a ‘smart city’ was popularised as a concept in the early 2010s to describe the use of these new advances in technology and data to make better decisions about governing cities and delivering services. Since then, interest in the concept has exploded, attracting influence, investment and criticism across the world.”**

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5. Many city governments see the opportunity to attract private sector investment. But they do not create good processes for managing engagement with the private sector. Smart city leads should consider how to give clarity to potential private sector partners.

These recommendations are drawn from the experience of all 21 cities in our research.

But there is much more research to be done. It is still not clear what smart city technologies are having the most impact and that is because the evidence of benefits is not well known or captured. That is why Future Cities Catapult has created an impact assessment framework, which we will use to create robust evidence on the impact that smart city solutions are having. With this evidence, we will be able to help guide governments towards new technologies that will have the greatest impact on their cities. ■

**Rushi Rama**

**Strategy, Markets and Standards Lead**

Future Cities Catapult

Tel: +44 (0)20 7952 5111

<http://futurecities.catapult.org.uk/>

[www.twitter.com/futurecitiescat](http://www.twitter.com/futurecitiescat)



**Come to Varberg. Share our vision.**

# Swedish West Coast's Creative Hot Spot

**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 take position as the Swedish West Coast's Creative Hot Spot**

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 historic 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. The Swedish Government makes great investments 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 harbor and have begun planning for a new waterfront area that connects the city centre with the coastline, as the industrial barriers are removed.

It is important for us that it is possible to lead a good life within the entire municipality and not only in the city of Varberg. Although most of the development for housing

is focused on the city, we have methods to involve residents living in our more rural communities too. We strive to 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. This is becoming ever more important as decision-making is moving farther and farther away from the people. 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.

In Varberg, we wish to involve people in the creative process. Our aim is clear and as such, we are acting on it. We are building a community converging around means of public transportation and a sustainable lifestyle. That we have momentum shows in the many awards we get.

The Municipality of Varberg has been appointed Sweden's Most Livable in the category of smaller communities for four years in a row now. Our thriving city centre was recently the 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 Placebrander of the year. We are proud of these awards and all the people that have worked so hard to make them possible and regard them as appreciative of our chosen path towards the future.





# REINVENTING THE COMMUNITY

## building on creativity

**C**reativity, 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.

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### **Best place to live**

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.

**Come to Varberg. Be inspired.**



# A timber frame BIM library to realise the benefits of BIM for SMEs

Alex Goodfellow, Chairman of the Structural Timber Association, details the launch of the first timber frame BIM library and why it's time for SMEs to embrace digital working

Historically, the construction industry has been one of the least digitalised sectors, relying on traditional design and construction methods to deliver projects. However, in recent years this has started to change, with the industry accepting that to deliver projects in the most efficient way, it must embrace new technology and digital working.

One of the major changes in the construction industry is the introduction of Building Information Modelling (BIM), which is a collaborative, digitally enabled design and construction process that uses 3D modelling to deliver a project across multiple professions and trades – from concept to facilities management.

The 2016 NBS National BIM report shows that 86% of respondents expected to use BIM in projects this year. This highlights that different sectors across the industry have embraced BIM and are using it as an alternative to traditional design methods. However, the majority of BIM-ready companies are large players, with small to medium-sized companies being left behind.

In order to address this, we have worked with the CITB through its Flexible Funding – Innovation pilots to carry out a 12-month study assessing the BIM readiness of small and medium builders. As part of this project, we have designed and launched a Stewart Milne Timber Systems BIM library, the first timber frame BIM library in the UK.

This timber frame BIM library features 112 products, including walls, floors and roof products, and is free to download from [BIM store](#). The use of the library will reduce lead-in time on a timber frame project by as much as a month by removing the need for a three-stage “back and forth” design process between architects and design teams. Instead, accurate 3D models

can be prepared immediately after downloading content from the BIM library.

As part of the project, a survey of our housebuilding supply chain partners was carried out to assess BIM readiness. Only 2% of respondents were BIM ready, with just 32% actually aware of BIM. This has brought into sharp focus the work that needs to be done to ensure companies have access to the necessary BIM content to develop BIM 3D models they can use, to great benefit.

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**“The use of the library will reduce lead-in time on a timber frame project by as much as a month by removing the need for a three-stage “back and forth” design process between architects and design teams.”**

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There has been a focus on the use of BIM in public contracts, with the UK government requiring adoption of BIM Level 2 on all its projects by last year. In parallel with this, private sector companies are also moving to BIM-enabled platforms, as it just makes good business sense to do so. Work will continue but it highlights the opportunities that could be missed by companies who are not up-to-date with the latest technology and embracing digitisation.

3D BIM parametric digital working is the future technology and will ultimately replace 2D CAD line drawings. The timber frame BIM library has been configured as simple drop-down tabs, with “five click” search and select principle, supported with a simple user-guide on how to download and use the information.

Once the 3D building model is complete, this can be sent to design teams, who can automatically create a 3D IFC file of the timber frame structure and export it



back into the BIM model. Thereafter, the 3D timber frame model can automatically create the timber frame manufacturing and on-site assembly drawings and material schedules. These can be fed direct to our automated production lines, using our existing CAD/CAM – human machine interface, production control system, which governs the automated manufacturing lines, ensuring a high-quality product is delivered efficiently and with little waste.

A feature of BIM is the ability to translate the 3D model into virtual reality, where clients can view the building before it is built, including the timber frame construction products used. In the future, the timber frame BIM library can be developed to 5D BIM format, including additional aspects such as cost, time and quality management.

It's encouraging to see the recognition from the industry of the benefits offered by innovations like BIM and digital working. Getting the whole supply chain ready to take advantage of it, not just the bigger companies with

the resources to invest, will be key to delivering the benefits to the most important part of the construction sector: the end user.

There is a wealth of information available to construction professionals on the Structural Timber Association website, from advice on structural timber systems to market reports and an online member's enquiry system. For more information visit: [www.structuraltimber.co.uk](http://www.structuraltimber.co.uk). ■

**Alex Goodfellow**  
**Chairman**

Structural Timber Association  
Tel: +44 (0)1259 272140  
[office@structuraltimber.co.uk](mailto:office@structuraltimber.co.uk)  
[www.structuraltimber.co.uk](http://www.structuraltimber.co.uk)  
[www.twitter.com/STAtimber](https://www.twitter.com/STAtimber)

# The key issues for rail in Europe today

Libor Lochman, CER Executive Director discusses the key issues for rail in Europe today and offers insight into areas for improvement

In May 2018, the European Commission is planning to publish its proposal for the next Multiannual Financial Framework (MFF), which will eventually translate into budgetary commitments for those political priorities that the Commission, the European Parliament and the EU Council will agree upon at the end of their interinstitutional negotiations. What will deserve funding continuity in the future? What new policies will need fresh resources? For which old policies can the budget be reduced?

Transport must form an essential part of the budget considerations; it is therefore high time to gather our thoughts on EU mobility, to decide what our priorities are and to plan for our future. And if the Union wants to confirm its commitment to decreasing the environmental footprint of its economy, it is imperative that greening of transport should necessarily be among its political priorities. In view of this, there is no doubt that rail must play a fundamental role in the EU logistics chain, as well as in all passenger services.

But is the way in which rail-relevant policies have been designed – and that includes a complex pattern of elements, policy initiatives and legislative texts – fully consistent with this imperative?

## Rail and the environment

Let's present a few figures: rail uses just 0.6% of the oil consumed in the EU in all sectors, whereas the same variable gets to 11.5% for aviation and 63.3% for road transport. Rail's impressive environmental performance is also evident in its specific CO<sub>2</sub> emissions calculated by the European Environment Agency:

Despite these facts, some EU legislation seems to be biased in favour of less sustainable modes of transport. Take the legislation on transport infrastructure

charging for instance: it has allowed so far for 99% of the road network to be used free of charge (42% of the motorway network), whereas railway operators are charged for every single kilometre of track their trains run upon.

Another example? When it comes to fiscal treatment, aviation counts on the benefit of VAT-free tickets for cross-border travel across the EU, something that does not apply to rail. And when it comes to the EU Emissions Trading Scheme (ETS), railways are paying the price of being almost fully electrified. Whereas they are charged for ETS allowances, other transport modes such as aviation and road are mostly exempt.

On the other hand, the European Commission and the EU legislators have been ready to commit a lot of resources under the Connecting Europe Facility (CEF) that is now in its last phase of implementation: more than €15 billion was invested in rail projects between 2014 and 2016 (€21 billion was the total allocation under the CEF Regulation), addressing more than 170 bottlenecks, 51 of which on cross-border sections. Let's not forget though that for every single CEF call during that period, the number of rail projects deemed eligible for funding by far surpassed the number that could be funded.

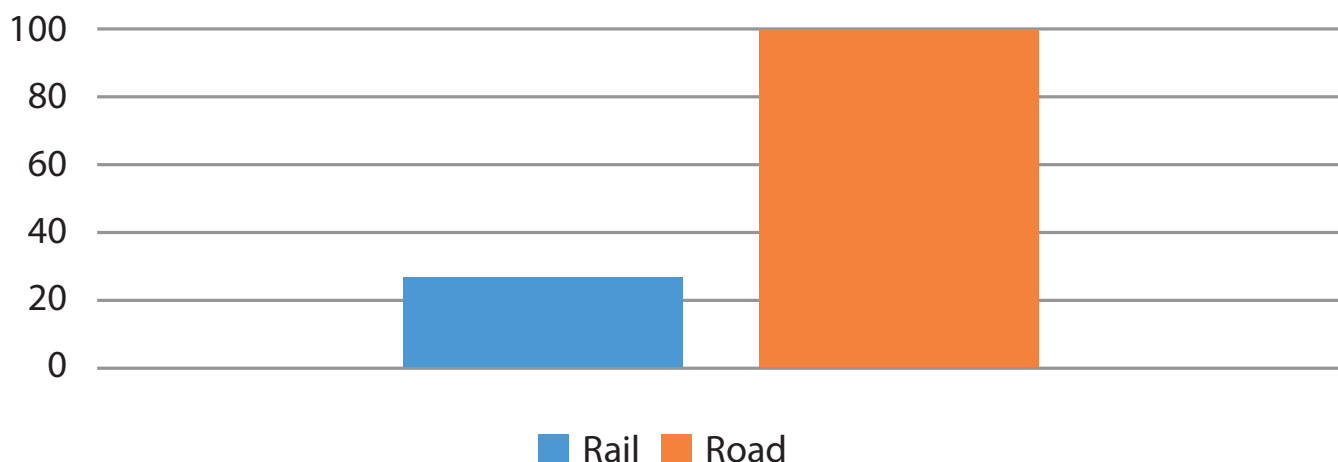
## Solutions

What conclusions should we draw? At least four broad ones:

1. The Connecting Europe Facility has proven to be the right choice and this instrument must not come to an end with the current MFF. More rail projects need and will need adequate investments. The continuation of this policy must, therefore, be ensured in the next MFF, with a strong fund-based approach.

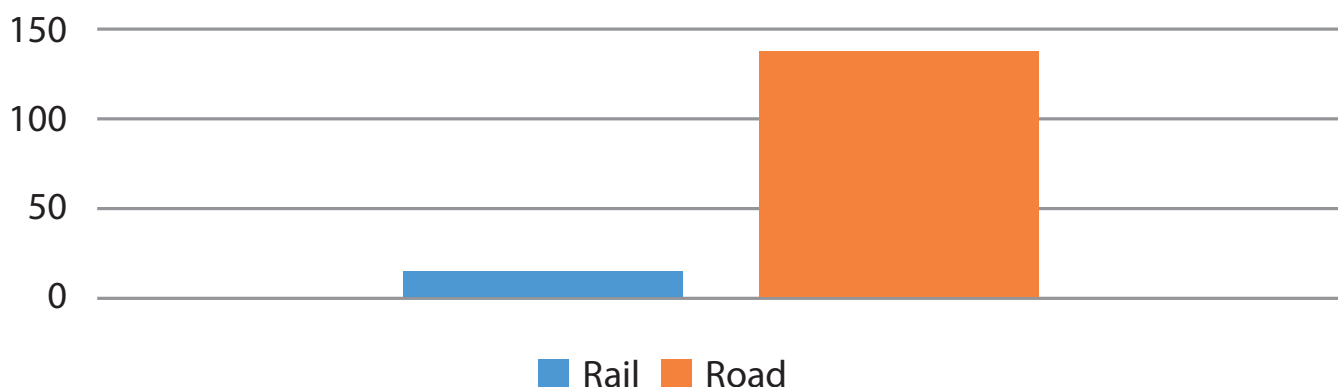
## CO<sub>2</sub> for PASSENGERS

Specific CO<sub>2</sub> emissions, g per passenger-km (EEA, 2014)



## CO<sub>2</sub> for FREIGHT

Specific CO<sub>2</sub> emissions, g per tonne-km (EEA, 2014)



2. To enable rail to do what it does best, intermodal competitive conditions must be addressed too. The current revision of the Eurovignette Directive is a further opportunity to put the road charging issue and internalisation of external costs back on the table. We must aim to ensure that the Commission proposal is not watered down.

3. Direct and indirect taxation is an aspect that deserves more focused attention.

4. New priorities must find adequate resources: digitalisation is a process that railway companies are already undertaking, but it must be accompanied by wise policy choices. ERTMS funding and financing is the perfect example for this.

If we want to bet on a sustainable, ever more efficient mode of transport for Europe, then rail should be our best bet. The whole EU economy and all European citizens will benefit from it. ■

**Libor Lochman**

**Executive Director**

Community of European Railway and Infrastructure Companies (CER)

Tel: +32 2 213 08 70

[contact@cer.be](mailto:contact@cer.be)

[www.cer.be](http://www.cer.be)

[www.twitter.com/CER\\_railways](https://twitter.com/CER_railways)



# Asset management in rail: cognitive computing

CEO of ZNAPZ, Marcel Van Velthoven provides a compelling perspective on how cognitive computing can assist asset management in rail

**T**he variables in the rail industry, especially in rail infra are numerous. Asset management in rail with all the variables in a reliable way is a challenge. However cognitive computing which has recently become available, can make a big difference. In the article below is described what kind of questions can be asked and what answers and reliable information can be obtained.

Assets just don't break or fail as a coincidence. Something has happened that has started or accelerated the deterioration process. Identifying what has happened or is happening becomes one of the standard possibilities with today's assets. This information can be obtained and with cognitive computing, a realistic prediction becomes possible. The challenge is to combine many different data sources and to develop a realistic pattern of the ageing of the asset.

## Some examples

It is well known that the rail and the rail system, switches, power lines are affected by the traffic. What was the speed of the train, what was the load of the train, what was the weather condition and what was the quality of the bogies that contacted the rail? Getting this data together, preferably in real time was, until recently absolutely impossible, however it is becoming standard today.



On today's tracks, the temperature of the track is permanently measured, as well as the vibration. This varies of course when a train passes. A train passing gives the first pattern of vibration and temperature of the track. This can be combined with the train speed and load and the weather conditions. This combination gives a good first impression of the effect of the passing train, on the quality of the track.

Taking it, a step further can per bogie be identified what the quality of the wheels, the roundness, is. Even a non-significant deviation does already have a significant effect on the rail track quality and life expectation. All this data can easily be send to a central computer which makes profiles of the train journey, speed and

load and the quality of the relevant assets in the train affecting the asset life of the track.

Looking ahead, when it comes to cognitive computing and Internet of things (IoT), real-time information can be interpreted and analysed. Taking in account all factors, e.g. customer delay minutes, asset life, maintenance cost and capabilities, we can generate a real-time signal identifying what the train speed should be along the trajectory that the train should take. It will become a dynamic journey, taking in account the trains time schedule and physical status of the train and the track.

Firstly, we can focus on asset life and deterioration, but soon we can identify



how special conditions lead to a shorter or longer asset life and how this can be optimised, taking in account the specific speed of the train under these specific circumstances.

Watson can make these predictions today. Even better with all the variables, even variables we may not think of today, Watson, the cognitive computer from IBM will be able to recognise patterns over time and dynamically adjust the recommended driving conditions for the train. A combination from trains driving close after each other may have an effect that currently isn't taken in account and also a passing train could have an effect.

With the dynamic guidance of Watson and the recommended speed, the train could be guided to pass the other train at the best-chosen area. This demonstrates how artificial

intelligence will make its entree in the rail infra world enabling the rail infra company to take appropriate actions, to generate the highest value from its rail assets over the lifetime, while managing risk and cost.

The non-standard deviations of the track can be identified using modern technology, such as drones or also measurement trains. The data gathered from these inspections can be interpreted by Watson, after a learning period, where Watson has been thought what is the right condition of the track and what is an abnormal condition. Bends, curves, corrosion, corrosion frequency and acoustic information can be analysed to create the most accurate profile of the status of the track.

Watson will support the asset operator to optimise rail performance, while minimising risk and cost in a real-time

fashion. This dynamically against all the measurable variable conditions that can occur. The first step is the asset operator should identify how Watson will be educated. Watson is the next step in rail asset performance.



**Marcel Van Velthoven**  
CEO  
ZNAPZ  
Tel: +31 402 668636  
info@znappz.com  
www.znappz.com



# How digital solutions enable efficient passenger handling at airports

Renjit Benjamin, Senior research analyst from Frost & Sullivan explores the world of airport passenger flow management, focussing on how digital solutions enable efficient passenger handling

The demand for air travel has been increasing over time with the International Association of Air Travel (IATA) expecting 7.2 billion air travellers in 2035 compared to the 3.8 billion travellers in 2016. While this increasing demand implies higher revenues and growth, airport stakeholders are expected to consistently increase their capacity while whittling down the operational costs and providing passengers with maximum value and a wholesome experience to ensure repeat engagements with the airport.

## Challenges due to growing demand

However, with limited physical capacity, airports are unable to handle the growing influx of passengers. The struggle to find adequate land mass for airports to increase its physical footprint and the high capital investment required forces them to delay such projects and instead, to invest in technology that can streamline operations to handle additional flights and passengers with the existing infrastructure. Implementing technol-

ogy is relatively less cost-intensive and has a reduced impact on daily operations.

Legacy airport systems are disparate and inefficient leading to long queues at passenger touchpoints such as check-in, security screening, border-control and boarding resulting in delays that impact the punctuality of flight schedules and airport efficiency gains.

Long waiting times at touchpoints combined with inadequate seating facilities, connectivity (Wi-Fi), overpriced parking and food stalls and lack of appropriate navigational services have shown to increase passenger frustration and stress.

These challenges necessitate a transformation in business models, operational processes and organisational activities, by leveraging emerging digital technology and transitioning from a flight operations-based business model to a passenger-centric model.



## Digital transformation of airports

In a research study completed in May 2017 wherein 50 global airports were interviewed, Frost & Sullivan identified that most airport operators invested in digital technology with the anticipation that a smarter airport would yield improved passenger experience and operational efficiency with more than 50% of CXOs agreeing that it was the most important programme, a key pillar, in their growth strategy. While more than 40% of airports expect their IT budgets to grow more than 5% in the next five years, the annual IT spending is expected to increase to \$4.6 billion by 2023.

The enthusiasm to invest and implement digital technology is driven by the necessity to digitise systems and processes, ensure seamless connectivity between stakeholders, airport systems, resources and assets and leverage data generated by these systems. Frost & Sullivan research identified that airports prioritise the passenger journey, implementing key projects that improved related KPIs. The research shows that 76% of airports have deployed solutions that manage passenger flow in terminals with another 18% planning to implement such projects by 2020, thus enabling them to achieve process efficiency and passenger satisfaction.

## Handling increased passenger flow

Passenger Flow Management (PFM) solutions enable airports, particularly with capacity constraints, to automate the handling of passenger flow in the terminal. Solutions such as video analytic solutions or sensors operated using low energy Bluetooth and Wi-Fi, track passengers and provide them information on queue wait times, airport location-based services and provide quick navigation across the airport.

The solutions also provide information regarding flight status, vehicle parking status and airport facilities. PFM solutions empower operators to forecast demand during peak operations and plan for various scenarios effectively using simulation tools. This helps operators to identify and mitigate bottlenecks in operational flow.

A general case study is the Cincinnati airport located in Northern Kentucky, USA, which witnessed 6.7 million passenger footfalls through its terminal in 2016. When faced with the growth of traffic by 80%, the airport deployed a passenger detection, tracking and queue management solution that used Wi-Fi and low energy

Bluetooth sensors to track and count passengers in queues and display wait times. The solutions helped the airport reduce the wait times at security lanes by 33%. This not only increased passenger satisfaction scores, but also increased the time passengers spent at the airport retail area.

Frost & Sullivan research anticipates the PFM market to grow from \$76.1 million in 2016 to \$184.0 million in 2025, with a CAGR of 10.3%. The current high implementation rate will slow down post-2020 with most constrained airports having enforced flow management solutions within this period.

Globally, European airports have been found to implement PFM solutions at a higher rate due to their physical capacity constraints, while airports in the United States are slower to adopt due regulatory obstacles and multiple terminal owners. The rate of adoption in the Middle East and Asia-Pacific airports continue to rise with more airports investing in digital platforms.

The implementation of digital initiatives has endowed technology providers with opportunities to provide solutions for varied airport challenges. The market is witnessing healthy competition among such providers leading to consolidation. Leading airport IT suppliers are acquiring niche solution providers or forging strategic partnerships to strengthen their product portfolio, facilitate growth and beat the competition. Additionally, continued product development through consistent investment in R&D and active participation in joint R&D programmes is key to innovation and long-term growth.

With the development of technology like NFC, biometrics and wearable smart devices, the avenues for managing passenger flow will expand. Apart from benefiting operators, these technologies will empower passengers with greater control over their journey. ■

## Renjit Benjamin

### Senior research analyst

Aerospace, Defense & Security

Frost & Sullivan

Tel: +91 (44)6160 6666

Renjit.Benjamin@frost.com

www.frost.com

www.twitter.com/Frost\_Sullivan



# New aircraft configurations

Professor Jonathan Cooper from the Faculty of Engineering at University of Bristol discusses the constant drive for aircraft manufacturers to develop more fuel-efficient designs and new configurations

Today's commercial jet aircraft all look very similar and haven't changed fundamentally over the past 50 years; essentially the designs consists of a tube containing the passengers with swept-back wings that have engines on pylons attached to them. There is a constant drive for aircraft manufacturers to develop more fuel-efficient designs, augmented by a strong push from the likes of the EU – for example via the Flightpath 2050 and Green Sky initiatives – that are setting stringent emissions targets for future aircraft designs.

Many new technologies have been introduced for passenger aircraft during the past half a century, including pressurised cabins, jet engines, composite materials, fly-by-wire control and loads alleviation systems, better aerodynamic wing shapes, winglets and higher by-pass engines. The laws of physics say that we can only make aircraft more efficient – e.g. travel more km per litre of fuel and be more environmentally friendly – through either having better engines, better aerodynamic shapes (often described in terms of increasing the ratio of lift to drag) or lighter structures.

However, despite the increased use of the above technologies, the improvement of aircraft efficiency against time is reducing. There is a need to make a step change in aircraft design, either through the development of new

technologies or alternatively by implementing alternative configurations (e.g. the layout of the fuselage, wings and tail). There are several likely candidates which all have some advantages compared to the conventional designs, but also some shortcomings:

## Longer wings

Aircraft with a higher aspect ratio (wing span divided average chord – long thin wings have a large aspect ratio, whereas short wide wings have a low aspect ratio) generate less drag and are therefore more aerodynamically efficient. However, a heavier structure is required to deal with the increased loads and there is also the problem of being able to fit in the airport gates; current studies are considering the use of folding wing tips on the ground in a similar way to storing aircraft on an aircraft carrier.

## Forward swept wings

Wings are swept back for aircraft that operate in the transonic flight regime as this reduces the aerodynamic drag that occurs when shock waves are present – however, the aerodynamic flow can separate towards the wing tips, which can have a detrimental effect upon the aircraft control. Sweeping the wing forwards rather than backward gives the same drag reduction capability and means that separation occurs towards the wing root, which has little effect upon the control of the aircraft.

However, sweeping the wings forward means that there is an unfavourable coupling on the wing when they bend upwards the wings also twist nose up, which can lead to the catastrophic aeroelastic phenomena of divergence. A solution for this effect is to exploit the properties of composite materials to eliminate the effects of the unfavourable couplings.

## Lifting fuselages

Current fuselage designs are usually circular which means that they do not provide any lift; however, they still add drag, which reduces the aerodynamic efficiency. A possible approach is to change the shape of the lower part of the fuselage so to that it can generate some lift in addition to that from the wings. Care would need to be taken to ensure that there wasn't too much increase in weight as a pressurised cabin is always trying to push the fuselage cross-section to become circular.

## Blended wing bodies

The natural extension of the lifting fuselage concept is to increase the width of the fuselage and change its shape to that of an aerofoil, combined with efficient wing designs so that the entire structure generates lift. This concept has been the subject of a lot of research activity in recent years, including the NASA/Boeing X-48 unmanned test plane. Potential disadvantages include the reduction in several emergency exit doors which limits



the time at which an evacuation could be performed and problems with passenger comfort in a roll manoeuvre if they are sat at the side of the much wider fuselage.

### Joined wing configurations

Many different configurations e.g. box-wings, have been proposed which eliminate discrete wing-tips (the end of the wing) using two wings on each side of the aircraft which are joined together in some manner. The rear wing is typically attached to the tail at a higher position than the forward wing is to the fuselage.

Supporters of this concept argue that there are both aerodynamic, the elimination of wing tips means that one of the main drivers for drag is eliminated and structural, the two wings can distribute the loads in a more efficient manner and therefore don't need to be so heavy, reasons why such an approach is desirable. More work, including the design of prototypes, is

required to determine whether such configurations are indeed beneficial.

### Distributed propulsion

A final configuration with lots of potential is to use several smaller propellers or jets distributed along the wing, rather than having a few propulsive devices attached to the aircraft. It has been shown that there are aerodynamic performance benefits in doing this and as the propulsion devices do not need to be so large, there is the possibility of using electrical propulsion such as in the NASA X-57 concept. Such an approach is still very much in its infancy.

### Concluding remarks

There is a growing need for aircraft manufacturers to develop aircraft that are more fuel efficient whilst being able to meet the growing demand for future air travel. Current aircraft configurations are becoming as optimised as possible and the required step-change improvements in performance

are likely to only be achieved through changing the configuration, possibly using one of the above designs, but it is not clear which is the best. Such a change is going to be highly risky for any manufacturer and therefore, it is likely to be decades before we see new configurations being flown outside of a research environment.



### Professor Jonathan Cooper

Faculty of Engineering  
University of Bristol  
Tel: +44 (0)117 33 15819  
j.e.cooper@bristol.ac.uk  
[www.bristol.ac.uk/engineering](http://www.bristol.ac.uk/engineering)

# Agenda 2030 and international aviation

Dr. Fang Liu, Secretary-General of the International Civil Aviation Organization, explores how international aviation contributes to Agenda 2030 by empowering local sustainable development through global connections

Every 24 hours, some 10 million global travellers are being carried around the world on just over 100,000 flights.

Commercial aircraft also carry over half of the world's 1.4 billion tourists to their destinations annually and many readers may be surprised to learn that these numbers are all presently forecast to double in just 15 years' time.

With the importance of aviation connections to local economic vitality and prosperity becoming much better appreciated, most especially in the context of the 17 UN Sustainable Development Goals (SDGs) adopted under Agenda 2030, it's critical that governments continue to work through ICAO today to ensure that future air transport growth is effectively managed and that air services expand sustainably and equitably.

## ICAO Compliance: A key enabler of sustainable development

To help assure this, the United Nations agency for civil aviation, ICAO, has been continuing to help States cooperate on the basis of more than 12,000 standards for global air transport adopted under the Convention on International Civil Aviation (Chicago Convention).

These ICAO provisions serve as an important foundation upon which governments can develop their local aviation infrastructure, operations and other capacities, consistent with other States' expectations and the existing global alignment of our network.

This greatly aids governments related ambitions to leverage, on behalf of their local citizens and businesses and the sustainable future of their civil societies, the distinct socio-economic benefits which derive from global aviation connectivity.

Today those benefits generate many positive impacts for the global economy, with our sector, directly and indirectly, employing some 63.5 million people, contributing over 2.7 trillion dollars annually to global GDP and moving over 3.8 billion passengers and one-third of world freight by value each year.

## The challenges of modernising a dynamic transport sector

When we talk about effectively managing the forecast growth in air transport, our sector is focused most intently on improving upon our current metrics for ICAO Strategic Objectives such as aviation safety, security and capacity/efficiency.

Some have likened this challenge to try to repair an automobile while it's still moving, and the task is further intensified by the fact that global aviation governance is so consensus-based. Forging common ground is never simple, but it's especially complex when you're serving 192 Member States characterised by greatly varying civil aviation and socio-economic needs.

ICAO, States and industry groups focus on capacity and efficiency in aviation because the speed by which modern commercial aircraft can move passengers and freight globally is the core value offering of international air transport.

Safety and security provisions complement this essential rapid transit attribute, establishing an overall foundation of speed, breadth, confidence and dependability which no other form of transport can equal.

ICAO also places a determined focus on the sustainability of our sector, as represented by our additional Strategic Objectives for the economic development and environmental performance of civil aviation.



*Dr. Fang Liu, Secretary-General of the International Civil Aviation Organization*

Environmental goals and challenges are especially urgent today given the current global context and we have been grateful for our States' leadership in helping our sector to achieve some key world firsts, whether in terms of new aircraft CO<sub>2</sub> emissions standards or the landmark international emissions offsetting solution represented by our recent CORSIA agreement.

## **The pressing need for globally-coordinated aviation development**

One thing we know for certain is that our network needs both new and modernised infrastructure established, especially if we're to manage future growth while still improving upon our sector's admirable safety and security results.

To help address these issues, whether, through our ICAO World Aviation Forums or other events and missions we undertake, ICAO is expanding global awareness at the highest levels on aviation's unique ability to connect cities and countries to the world.

We are stressing to ministers and state planners everywhere that, to optimise aviation's significant socio-economic benefits, their aviation infrastructure and related development needs should be incorporated into their national development plans and strategies.

We also, of course, wish to engender higher levels of investment for the large-scale air transport infrastructure modernisation now needed, whether in developed or developing States. To that end, our World Aviation Forums are essentially designed to forge new partnerships among aviation, finance, donor and development communities and to help our Member States realise business plans consistent with investor expectations for transparency and accountability.

Our expectation is that this work will foster sustainable economic growth for governments which make the necessary commitments and follow through successfully on both their projects and investments.

This, in turn, will greatly expand local access to foreign markets and producers, amplifying business opportunities and engendering more dependable and positive employment and tax base impacts, permitting further staged growth.

And another important piece of this puzzle will be the numbers of skilled young men and women available to operate our technologically, logistically and politically complex global network.

Just this year we hosted our first Global Summit for Next Generation Aviation Professionals and initiated an ICAO Gender Equality Programme, both of which help to address our future aviation workforce and human development challenges in league with ICAO's Global Aviation Training office.

Aviation is now poised to usher in a 21st-century air transport network which will serve as a key enabler of local economic vitality and sustainable development by optimising global connections. This role is directly consistent with the convention which established us and a testament to the vision of its drafters. ■

### **Dr. Fang Liu**

#### **Secretary-General**

International Civil Aviation Organization (ICAO)

Tel: +1 514 954 8219

[icao@icao.int](mailto:icao@icao.int)

[www.icao.int](http://www.icao.int)

[www.twitter.com/icao](https://www.twitter.com/icao)

[www.twitter.com/icaoFangLIU](https://www.twitter.com/icaoFangLIU)



# The Oceans Protection Plan is transforming marine safety in Canada

Canada's Minister of Transport, The Honourable Marc Garneau explores the Oceans Protection Plan and how this is transforming marine safety in Canada today

**P**rime Minister Justin Trudeau's announcement in November 2016 of the \$1.5 billion Oceans Protection Plan marked the largest ever investment to improve marine safety and protect Canada's coasts.

Since then, the government has launched more than a dozen innovative initiatives as part of the Oceans Protection Plan and, in the coming years, will continue to dedicate resources to improve Canada's marine safety system, build and enhance emergency response capacity and protect the marine environment. This is the government's most comprehensive plan to protect our coasts and the most ambitious investment in our oceans ever made by the Government of Canada.

Several methods to better protect Canada's coasts are being explored. Among challenges faced by our coastal communities are managing marine traffic congestion and improving local understanding of the activity taking place in their waters. The Anchorages and Enhanced Maritime Situational Awareness initiatives, under the Oceans Protection Plan, address this need directly.

## Addressing marine traffic congestion in Canada

In Canada, the right to anchor a vessel is part of the common law right of navigation. A vessel is also free to anchor temporarily and for a reasonable period of time in any appropriate location, unless specifically prohibited by laws or regulations. However, Canadian port authorities assign and manage anchorages within their boundaries. When a port's anchorages and terminals are full, vessels must anchor elsewhere until space becomes available.

The Government of Canada is working with the marine industry, Indigenous peoples, community organisations and stakeholders to develop a process to identify anchorages. Analysing and responding to environmen-

Image: © CdC-HoC



*The Honourable Marc Garneau, Canada's Minister of Transport*

tal, economic, cultural, safety and security concerns and drafting a manual of best practices for ships at anchor is part of this initiative. It is also proposing oversight and management options for these anchorages.

By working closely with those who are most affected, we are taking action to make maritime information more available and to reduce marine traffic congestion. This will help ensure marine shipping in Canada is safe, responsible and better prepared to protect the environment and coastal communities.



### Improving local maritime situational awareness

Canada's Indigenous peoples and coastal communities need user-friendly local data on marine traffic for several purposes. In response, the Canadian government is developing a new maritime awareness information system that will provide a user-friendly tool to increase access to local maritime information, including vessel traffic, for Indigenous partners, coastal communities and stakeholders.

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**“The Government of Canada is working with the marine industry, Indigenous peoples, community organisations and stakeholders to develop a process to identify anchorages. Analysing and responding to environmental, economic, cultural, safety and security concerns and drafting a manual of best practices for ships at anchor are part of this initiative. It is also proposing oversight and management options for these anchorages.”**

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This new system will enable Indigenous peoples and coastal communities to work hand-in-hand with safety authorities. It will integrate existing and new sources of information, including support from space-based Automatic Identification System (AIS) data services.

Collectively, we'll be better able to understand maritime activity in local waters, improve communication and col-

laboration between all parties. This innovative system will lead to stronger marine safety planning, pollution prevention and emergency response capabilities.

Strong collaboration and state-of-the-art technology will result in a more comprehensive and coordinated response to marine emergencies and better safeguarding of our coastal environment.

We need the participation of Indigenous peoples, coastal communities and industry to make sure that the solutions developed to solve the challenges we face. There will be several opportunities to provide input into decisions and there is much more to come as players collaborate in finding solutions to protect our coasts.

<https://www.tc.gc.ca/en/campaigns/protecting-coasts.html>

### **The Honourable Marc Garneau Minister of Transport**

Office of the Honourable Marc Garneau

Tel: +1 613 991 0700

<http://www.tc.gc.ca/eng/menu.htm>

<https://pm.gc.ca/eng/minister/honourable-marc-garneau>

# EUFAR – Looking to the future of airborne environmental research in Europe

Philip R.A. Brown from EUFAR AISBL at the UK's Met Office takes us on a journey to explore the exciting future of airborne environmental research in Europe today

Instrumented aircraft are an important scientific tool, allowing researchers to observe the atmosphere and land and ocean surfaces in support of a wide range of applications in the environmental sciences. EUFAR – the European Facility for Airborne Research – promotes collaboration between the operators and scientific users of research aircraft, seeking to broaden access and improve efficiency in the use of these resources.

EUFAR ([www.eufar.net](http://www.eufar.net)) has been supported by the 7th Framework Programme (FP7) of the European Commission. It combines 24 European institutions and organisations involved in airborne research, operating 19 instrumented aircraft and 5 remote-sensing instruments, providing a broad measurement capability.

There is a long history of airborne observational research contributing incremental developments in the scientific understanding of earth-system processes. These developments have proceeded in parallel with similar developments in the capabilities to observe these processes on a global scale from space and to model them in operational Numerical Weather Prediction (NWP), climate and Earth-System models.

The fields of science that are impacted by an airborne research observing capability are very broad and span the atmosphere, ocean, land surface and biological systems. Maintaining access

to a broad range of airborne observing facilities is critically important to our future ability to study processes in the environment and to develop and use the models that will, for example, be used to study mitigation strategies in a changing climate.

## EUFAR AISBL

A key outcome of the present consortium has been the agreement of several leading partners to constitute EUFAR as an international non-profit association (AISBL). This organisation will provide a framework for European collaboration in airborne science beyond the framework of funding from the European Commission. The objectives of the AISBL are broadly the same as the present consortium, namely to:

- Develop open access to national facilities, broadening the scientific user base and providing users with access to a facility best suited to their scientific requirements;
- Improve the quality of the services provided by aircraft and instrument operators by strengthening expertise through knowledge exchange;
- Develop and maintain a central database of airborne data and the standards for this database to be interoperable with other environmental science and Earth observation databases;
- Support joint instrumental research activities centred on the development of improved data processing and calibration techniques;
- Promote the use of research aircraft and instruments by providing educa-

tion and training courses on airborne research topics and;

- Support innovation in airborne research, working with industry to transform airborne research instruments, methodologies and software into new products and services.

Membership of the AISBL is open to any institution with a scientific or technical interest in the development and application of airborne facilities in environmental research. The founding members of the AISBL includes eight different organisations in six European countries:

- VITO, Belgium;
- CzechGlobe, Czech Republic;
- CNRS, France;
- Météo-France, France;
- ONERA, France;
- DLR, Germany;
- University of Warsaw and;
- Met Office, UK.

In addition, INTA (Spain), CNR (Italy), Free University of Berlin (Germany) and Tel Aviv University (Israel) are well-advanced on the formal path to membership, and other organisations in the UK, Romania and Greece have expressed an interest in membership.

The airborne research community is widely spread across national meteorological services, other national public research centres, universities and SMEs. Any interested organisation that is unable to participate in the AISBL as a fee-paying member can do so as a partner. Partners will be able to partic-



*Figure 1. The Bae-146 of the Facility for Airborne Atmospheric Measurements (jointly operated by Natural Environment Research Council and Met Office) in the UK. This aircraft is comprehensively-equipped for measurements of atmospheric aerosols, cloud and precipitation particles, trace gases and radiometry from visible to sub-millimetre wavelengths*



*Figure 2. The Falcon-20 of DLR, Germany. This aircraft is equipped for a wide range of atmospheric measurements and has participated in many national and international observing campaigns over a long career. It has recently seen significant demand through the EUFAR Transnational Access process*



*Figure 3. The CASA-212 airborne remote-sensing aircraft of INTA, Spain. This aircraft carries a range of hyperspectral imaging sensors from visible to thermal infra-red wavelengths and has also been in high demand through EUFAR Transnational Access*

ipate in AISBL activities and attend its meetings but without a role in the formal governance of the association.

EUFAR AISBL actively welcomes wider participation in its activities. Any organisation wishing to join EUFAR AISBL in future, either as a member or partner should contact the Executive Board Chair in the first instance.

### **EUFAR AISBL facilities and capabilities**

EUFAR AISBL members will provide access to several leading airborne research facilities (both aircraft and instrumentation). These include:

- BAE-146, Facility for Airborne Atmospheric Measurements (FAAM), UK;
- Falcon-20, HALO and Do-228, Deutsches Zentrum für Luft- und Raumfahrt (DLR), Germany;
- ATR-42 and Falcon-20, Service des Avions Français Instrumentés pour la Recherche en Environnement (SAFIRE), France and;
- CASA-212, Instituto Nacional de Técnica Aeroespacial (INTA), Spain.

Other aircraft and instruments operated both within the AISBL and by other institutions in Europe can be viewed on the EUFAR website ([www.eufar.net](http://www.eufar.net)).

These provide state-of-the-art measurements, both in-situ and remotely-sensed, that cover a broad range of scientific applications that include but are by no means limited to:

- Atmospheric aerosol physical, chemical and optical properties;
- Cloud microphysics and precipitation development;
- Atmospheric trace gases and their evolution;
- Atmospheric radiative transfer and spectroscopy, from visible to sub-millimetre wavelengths, including the development of measurement capabilities for future space-borne application;
- Vegetation studies including responses to environmental stress factors;
- Soils and mineral characterisation;
- Physical and biological processes in rivers, lakes and inshore waters;
- Energy exchange processes at the land and ocean surfaces;
- Cryospheric processes;
- Calibration and validation of space-borne measurements.

### **Links to other European environmental research infrastructure activities**

It is very common that airborne measurements are combined with those from ground-based or ship-borne platforms as part of joint observing campaigns at both national and international level. Scientific users of airborne data will be assisted in their efficient exploitation of these facilities when common approaches to data and metadata formatting, storage and access are used by the different observing infrastructures.

ENVRIplus ([www.envriplus.eu](http://www.envriplus.eu)) is a Horizon 2020 project bringing together Environmental and Earth System Research Infrastructures, projects and networks together with technical specialist partners to create a more coherent, interdisciplinary and interoperable cluster of Environmental Research Infrastructures across Europe.

EUFAR is represented in its governing board and will work closely with related infrastructures in the atmospheric, ecosystem and oceanic domains to maximise the benefits of the large investments that are required to provide and maintain world-class airborne observing facilities in Europe.



**Philip R.A. Brown**  
**Executive Board Chair**  
 EUFAR AISBL  
 Met Office  
 Tel: +44 (0)1392 886 740  
[phil.brown@metoffice.gov.uk](mailto:phil.brown@metoffice.gov.uk)  
[www.eufar.net](http://www.eufar.net)  
[www.twitter.com/EUFAR\\_science](https://twitter.com/EUFAR_science)



# Breathing space – EU efforts to clean up Europe's air quality

Karmenu Vella, European Commissioner for Environment, Maritime Affairs and Fisheries lifts the lid on EU efforts to clean up Europe's air quality

In Europe, the air we breathe is cleaner than it has been for decades. Air pollution is coming down and on many days, the sky looks clear.

But appearances can be deceptive because many of the dangers are invisible. Across the EU, premature deaths from air pollution are now some 15 times higher than fatalities from road traffic accidents. As I often say, you can keep off the roads, but you can't stop breathing air.

Despite the positive trends, air pollution remains the number one environmental cause of premature death in the European Union. It still causes more than 400,000 premature deaths every year and it brings respiratory and cardiovascular diseases to millions more. The economic costs of air pollution in the EU are well over €20 billion a year.

The European Commission is committed to addressing these issues and to cleaning up Europe's air. Our citizens deserve air that is safe to breathe and that poses no significant risks to health and the environment.

There is good progress to report. In the first 15 years of this century, we saw the combined GDP of the European Union grow by 32%, while emissions of the main air pollutants actually decreased, for example by 10% for ammonia and by 70% for sulphur dioxide (SO<sub>2</sub>). But we cannot ignore the persistent and avoidable health costs from pollutants.

Last year Europe's leaders signed new pollution limits into law. These new standards, in the National Emissions Ceiling Directive, will halve the negative health impacts of air pollution by 2030.

But laws are only useful when they are actually



enforced. When a Member State fails to live up to that obligation, Europe steps in. Many air quality standards have been in place for decades and that's why we are taking legal action to push the Member States into complying with them.

Infringements aren't the only course of action we have at our disposal. In 2017 the Commission launched "Clean Air Dialogues" with three Member States and more are on the way.

Another tool in the box is the Environmental Implementation Review. These bilateral exchanges allow the Commission to explore options with Member State authorities and with regions and cities as well, helping them identify the places where implementation isn't working and filling those gaps with solutions we find together.

Very often, those solutions are ready and waiting. But tackling air pollution successfully requires a concerted



approach, combining various different strands. We need to bring disparate economic sectors like transport, energy, agriculture and industry together. We need to convince different levels of governance – at the European, national, regional and city level – to actively cooperate. And we need to ensure that different policy areas such as environment, climate and energy, mobility, agriculture and fiscal policy, are all pulling in the same direction. While keeping Europe's citizens at the heart of these issues all the while.

As the UK knows very well, cities don't just generate their own pollution: they also suffer from pollution that originates elsewhere. Air pollution, especially particulate matter, can travel long distances. As well as strengthening the case for action at the European level, this also underlines the need for a concerted approach at the domestic level.

One of the unexpected sources of particulate matter, for example, is agriculture. Livestock farming and manure spreading can release ammonia into the air, where it combines with other chemicals to form secondary particulate matter. It's an enormous problem across the continent.

It's a clear demonstration of the impossibility of solving problems in isolation. Tackling air pollution means tackling transport emissions, it means rethinking some of Europe's energy system and it means involving farmers as part of the solution.

Air quality is one of the most fundamental tests of any society. If we fail this test, then ordinary people and vulnerable groups, risk paying the ultimate penalty. Just like the pollution itself, the costs are often hidden, but just like the costs, that does not make them any less real.

These problems can be avoided. Europe already has the structures and the technologies that we need. But we have to do a better job of ensuring they get used. There is too much at stake for us to fail. ■

**Karmenu Vella**

**Commissioner for Environment, Maritime Affairs and Fisheries**

European Commission

Tel: +32 2 299 96 96

[ec.europa.eu/commission/commissioners/2014-2019/vella\\_en](http://ec.europa.eu/commission/commissioners/2014-2019/vella_en)

[www.twitter.com/KarmenuVella](https://www.twitter.com/KarmenuVella)

# EuroAcademy: An institution of many specialist areas

Juri Martin from EuroAcademy explores the specialist areas this private institution of professional higher education offers, which was founded in 1997

EuroAcademy is a private institution of professional higher education, founded in 1997 by NGO Eesti Euroinfo Ühing. EuroAcademy provides both professional higher education and Master's studies. Instruction is conducted in the following five faculties: The Faculty of International Relations, the Faculty of Translation, the Faculty of Business Management, the Faculty of Environmental Protection and the Faculty of Design. EuroAcademy is the only Estonian private higher educational institution providing education in various areas.

Another peculiarity includes the fact that all specialities are mutually connected. Instruction in all curricula is available in three languages: Estonian, Russian or English (except the curriculum of Translator). The number of specialities offered in Russian is the largest in Estonia.

## Vision

### Academic competence and international dimension

EuroAcademy is a well-known private university recognised both in Estonia and abroad providing students with high-quality, practical and interdisciplinary higher education on three academic levels. We develop international cooperation with foreign partner universities in the spheres of higher education and research. Our lecturers are welcomed guests at foreign uni-



versities and, similarly, we are an attractive destination for visiting lecturers.

### Networking and cooperation

Students and lecturers of EuroAcademy conduct studies and research on an international level, speak at international conferences and publish the results of their studies in internationally renowned journals. Similarly, EuroAcademy is a member of international research networks with the students and lecturers participating in various cooperation projects of their field.

### Academic integration and innovation

On the basis of both academic and applied research, EuroAcademy has built competence centres in the faculties of Environmental Protection, Translation and International Relations and it is in the given fields that the academy has

become a renowned leader of innovation. In combination with the integrated minor specialities, the curricula form a comprehensive and coherent knowledge base. EuroAcademy has firmly retained its place among the top twenty European small universities (EBA the Best Universities Ranking 2014 – Best Regional Universities, Europe; Western, Eastern and Central).

## Mission

The mission of EuroAcademy is to provide top-quality higher education and develop contemporary knowledge to provide our students with competitive education and preparation for working either in Estonia or elsewhere.

### Social cohesion

The mission of providing a wide selection of opportunities for finding an appropriate specialist area, and acquiring a comprehensive education and preparation for the future, is an important aspect of professional

higher education for EuroAcademy. In addition, the apprenticeship period prepares students for labour market requirements. We highly value the feedback provided by both employers and apprenticeship supervisors and as such, we employ such information in the development of the curricula. Similarly, we provide training courses supporting the concept of lifelong learning.

## Knowledge-based society

The mission of EuroAcademy is to contribute to society by providing high-quality education, as well as promoting research and culture. The mission of our competence centres is to be the originators and implementers of innovation in their particular area. The aim of the integrated minor specialities of EuroAcademy is to create new opportunities for sustainable development in the economy of the future.

## Sensitivity to society (in terms of educational policy)

It is the mission of EuroAcademy to base its curriculum development on both the needs and tendencies of the society and the labour market to contribute towards the achievement of the goals of Europe 2020 and the respective programmes. The academy highly values the higher education quality assessment and guarantees concerning the quality assurance of the education provided by its curricula.

## Core values

The core values forming the basis of the activities and communication of EuroAcademy:

- A student-centred approach, flexibility and tolerance – The academy

values highly its students and thus commits to the development of a solid academic community and friendly environment. EuroAcademy is thus also open to students of various cultural backgrounds.

- Academic freedom, creativity and autonomy – although building its activities on knowledge, the Academy also supports both academic freedom and creativity. As a private higher education institution, EuroAcademy is independent of its development priorities.
- Knowledge-based approach – the instruction is knowledge-based.
- Contribution to society – EuroAcademy is committed to contributing to society by providing high-quality higher education and research, while promoting cultural traditions and creating new ones for both the Academy and society more widely.
- Ethics – EuroAcademy strongly condemns plagiarism and as such, it relies on its code of ethics.

## Goals of EuroAcademy

In closing, the goals of EuroAcademy can be summarised as follows:

- To establish minor specialities integrating the syllabi of the curricula.
- To continue the regular publication and international dissemination of the academic journal of the Academy, The Baltic Horizons.
- To establish alumni societies at each faculty and the tradition of regular meetings to find the new apprenticeship and job opportunities, as well

as other forms of cooperation supporting the goals and activities of EuroAcademy.

- To revive student competitions, for instance, photography, translation, essay competitions etc.
- To enhance international cooperation with Nordic and Russian universities.
- To establish MA curricula in all specialities.
- To devise and implement at least two doctoral curricula. The prerequisites for it include positively evaluated research work, effective international cooperation and the regular publication of the academic journal of the Academy, The Baltic Horizons.
- To re-establish the status of a university and the name Euroölikool (EuroUniversity).
- To maintain the position of EuroAcademy among the top twenty small European universities.



**Mr. Juri Martin**

EuroAcademy

<http://euroakadeemia.ee/en/>



# Decisions around a changing climate

Director of the Climate Service Center Germany (GERICS), Prof Dr Daniela Jacob outlines the fundamentals of climate change and what it could look like in the future

**A** lack of accessible, policy-relevant and targeted information on the climate and potential future climate change remains prevalent in many regions of the world today. This can act as a hindrance to many investments and scientific projects, where proving the level of a project's susceptibility to climate impacts is now often mandatory for both consideration and approval. To meet this identified information gap, the Climate Service Center Germany (GERICS) has been developing tools which allow the presentation of both policy-relevant consideration and approval.

Many investment projects in the field of international cooperation (e.g. infrastructure) aim for a long duration. Therefore, such projects must be climate proof on a long-time horizon. This implies that state-of-the-art information about possible climate change and climate change impacts must be considered in the planning and deci-

## Annual mean temperature

- Likely range of projected change in annual mean temperature is from +0.9 to +1.4°C by 2030, from +1.3 to +2.3°C by 2050 and from +1.4 to +4.2°C by 2085
- Very likely range: +0.8 to +1.7°C by 2030; +1.0 to +2.7°C by 2050; +1.1 to +5.1°C by 2085.

Separate scenario examination (by 2085):

- **Low-Scenario:** Median +1.2°C

- **High-Scenario:** Median +3.9°C

Comparison to projections of IPCC AR4:

- Latest AR5 projections show same magnitude of increase but with a substantially larger bandwidth.

Range of projected changes for all simulations with global mean warming below 2°C or above 4°C (by 2085):

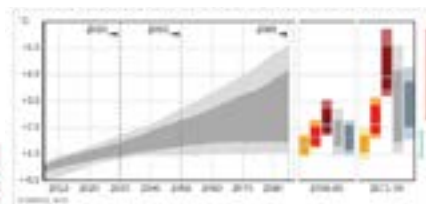
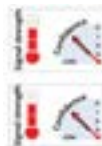
- **below 2°C-target:** +0.9 to +1.9°C
- **above 4°C-threshold:** +2.3 to +5.7°C



## Maximum and minimum temperature

The trends of maximum and minimum temperature are consistent with the trend of annual mean temperature depicted above.

- Likely range of projected change in **annual maximum temperature** is from +0.9 to +1.6°C by 2030, from +1.2 to +2.5°C by 2050 and from +1.3 to +4.1°C by 2085.
- Likely range of projected change in **annual minimum temperature** is from +1.0 to +1.7°C by 2030, from +1.4 to +2.7°C by 2050 and from +1.5 to +4.8°C by 2085.



Scenario	Measure	Max-Temperature	Min-Temperature
All	Steady	+1.3 to +4.1	+1.0 to +4.0
	Very likely	+1.0 to +3.0	+0.8 to +3.0
Low	Steady	+1.0 to +2.0	+0.8 to +1.8
	Very likely	+0.8 to +1.8	+0.6 to +1.8
Medium	Steady	+1.5 to +2.7	+1.2 to +3.2
	Very likely	+1.2 to +2.2	+1.0 to +3.0
High	Steady	+2.0 to +4.0	+1.5 to +4.8
	Very likely	+1.5 to +3.0	+1.0 to +3.8
Warming thresholds	Below 2°C	+0.9 to +1.9	+1.0 to +1.9
	Above 4°C	+2.3 to +5.7	+1.5 to +4.8

Figure 2: Detailed excerpt from CFS (Benin – Ghana – Togo)

sion-making process. Climate change information is widespread and freely available via various sources. The most comprehensive information source being the IPCC Assessment reports ([www.ipcc.ch](http://www.ipcc.ch)) provides information mainly on a global to continental/regional scale. But information is also available on regional scales (e.g. country reports).

While access to general climate change information might not be problematic for end users there is a high chance, however, that they are overwhelmed by the information available and struggle to interpret the information. Issues regarding multi-model-multi-scenario ensembles of climate change projections are rather complex and are often not taken up by the end user.

It is important to look behind the pure climate change information and include meta-information such as the size of the ensemble, the number of different emission scenarios, the spatial and temporal resolution of the data, the design and quality of the models and so on into the interpretation of the results.

To do this, expertise in the handling and interpretation of climate model output is necessary, which cannot be



Figure 1: GERICS Climate-Fact-Sheets



*Figure 3: Currently Climate-Fact-Sheets are available for indicated countries*  
*Blue – CFS based on data from global climate models*  
*Orange – CFS based on data from regional climate models*  
*Grey – planned CFS*

expected from the standard end user. This, therefore, leads to the situation that the rate of climate change information being up-to-date used in the decision-making process is directly linked to both the personal knowledge and enthusiasm of the individual end-user. This could lead to the fact that in the end, climate change information is not comparable between different projects within the same region or context.

Based on the need for consistent climate information, the Climate Service Center Germany (GERICS) together with the KfW Development Bank, jointly developed the concept of the Climate-Fact-Sheets (CFS). The Climate-Fact-Sheets summarise projected changes for a variety of different climate parameters, based on countries or regions. The climate change information is taken from the latest multi-model multi-scenario ensemble of global and regional climate projections to highlight changes in different emission pathways.

This allows projects in science, industry and finance, which take place within or across different global regions, nations, or climate zones, to quantify projected changes for different climate variables and comparable worldwide.

Additionally, the CFS provide statements on the climate history of the targeted area, as well as both general and key climate characteristics of both recent and current time periods. This gives the reader a broad understanding of the specific climatic backdrop to which they look to work within.

The focus of the CFS is providing concise analyse on projected future climatic trends. These trends concern each of the climate indices, based on three 30-year periods until 2100.

The creation of the Climate-Fact-Sheets emerges through careful analysis and compilation of a large amount of data available from both regional and/or global model simulations. Information for the CFS is gathered from two sources: primary data, such as projections from global and regional climate models or continental wide observational datasets and a literature review. Where possible, the focus is provided on uncertainties and the robustness of projects changes, respectively. References are also available to follow up on the information provided.

Each Climate-Fact-Sheet delivers standard information on the following climate parameters: annual mean,

minimum and maximum temperatures, heat waves, cold spells, total annual and mean monthly precipitation, dry spells, intensity and frequency of heavy rain events, actual evaporation, climatic water balance, mean solar irradiance and mean wind speed. Additionally, if appropriate, changes in mean sea level are included into the Climate-Fact-Sheets.

The accessibility of the information is essential and so the CFS is provided in compact forms, usually 5 to 6 pages long and are compiled from short text passages, tables and diagrams. Combined, the overall result is consistent, reliable and easily accessible climate information.

Currently, 58 CFS's have already been compiled by GERICS. These are readily available and accessible and span countries and regions across eastern Europe, Asia, Africa and Latin America, focusing on developing countries and regions.

The CFS is provided free of charge by Climate Service Center Germany (GERICS). For more information about them, including how to access your own fact sheet, please visit our website at: [http://www.gerics.de/products\\_and\\_publications/fact\\_sheets/climate\\_fact\\_sheets/index.php.en](http://www.gerics.de/products_and_publications/fact_sheets/climate_fact_sheets/index.php.en)



**Prof Dr Daniela Jacob**  
**Director of Institute**  
 Climate Service Center Germany (GERICS)  
 Tel: +49 40 2263 38406  
[daniela.jacob@hzg.de](mailto:daniela.jacob@hzg.de)  
[www.climate-service-center.de](http://www.climate-service-center.de)



# Aalto University Arctic marine technology and vessel safety

Pentti Kujala from Aalto University provides a fascinating glimpse into the institution's work on improving the safety of vessels present in harsh sea ice environments

The research group on Arctic marine technology and safety at Aalto University School of Engineering works towards improving the safety of vessels navigating in harsh sea ice environments, combining expertise in mechanical engineering, naval architecture, safety engineering and risk management. The multidisciplinary approach aims to create new knowledge about the interactions of sea ice with vessels in ship design and operational contexts. This is applied in practical applications or supports marine policy.

The group owns the Aalto Ice Tank, which is a 40m × 40m water basin equipped to produce sea ice in model scale. The facility is unique because of its dimensions and its large width. During 2014-2016, the Aalto Ice Tank has been totally renovated and upgraded with funding from the Academy of Finland Infrastructure Call and from the Ministry of Education and Culture. Finally, the research group is an active partner in various national and international research projects and collaboration networks, and actively engages with stakeholders to

disseminate results and to facilitate their implementation.

## **Lloyd's Register Foundation CEARCTIC**

**Research Centre of Excellence for Arctic Shipping and Operations**  
(<http://cearctic.aalto.fi/en/>)

The scope of the Lloyd's Register Foundation Centre of Excellence is the holistic treatment of design relevant features and their identification to advance safe arctic operations and transport. Holistic risk analysis typically includes a definition of hazard

scenarios, their occurrence probability and consequences. For arctic operations, the definition of all these three elements is challenging due to data scarcity, the complexity of the sea ice environment and the stochastic nature of the ship-ice interaction. This holistic treatment is achieved through developing appropriate design frameworks, ensuring a consistent link between the different elements in the scenarios, while analysing their implications for the conceptual phase of ship design.

This holistic risk-based design approach advances the state of the art by explicitly identifying the scenarios, occurrence probabilities and consequences, making use of state of the art and newly developed first principle methods. Another key aspect of this novel design approach is its focus on the design relevant actions occurring during the entire life-cycle of the ship or installation, and not only on the initial service load conditions. This is followed by a selection of required safety features based on standard regulations.

## SEDNA

**Safe maritime operations under extreme conditions; the Arctic case**  
Maritime traffic in the Arctic region is rapidly increasing, posing safety risks to human activities in the Arctic, while raising concerns about environmental pollution. Safely operating vessels in Arctic environments is a prerequisite for sustainable transportation and economic growth. The SEDNA project aims at developing an innovative and integrated risk-based approach to safe Arctic navigation, ship design and operation, to enable European maritime interests to embrace the Arctic's significant and growing ship-

ping opportunities while safeguarding its natural environment.

The project creates and demonstrates improved safety outcomes through focusing on two aspects: the safe Arctic ship and safe Arctic navigation. Aalto University participates in the development of a risk-based design framework to ensure that vessel design is connected to all key hazards of ship operation in the Arctic.

## BONUS STORMWINDS

### Strategic and operational risk management for wintertime maritime transportation system

Maritime transportation is of vital importance to the countries surrounding the Baltic Sea area. During winter, ship navigation is challenging due to the presence of sea ice, especially in the Northern Baltic Sea area. Accidents occur more frequently than in open water conditions and although the consequences typically are minor, serious accidents involving oil spills could occur, potentially leading to significant environmental and economic damages. BONUS STORMWINDS addresses these risks on several accounts.

A first research theme concerns risk-informed planning and decision making for maintaining necessary response capabilities for possible accidental pollution. Knowledge is generated about navigational accidents in ice, about the future sea ice climate in the Northern Baltic Sea and about oil spill recovery effectiveness in ice. Improved oil outflow models from damaged tankers in ice conditions are developed, and the state of art SeaTrack Web tool is improved to better account for oil drift in ice conditions.

A second research theme is the development of approaches for enhanced situational awareness and operational planning for ship navigation in Baltic Sea ice conditions. A method is developed for classifying satellite images in terms of expected ship performance and method is developed to support operational route planning in the sea ice environment, accounting for ship performance and safety.

A third research theme focuses on developing an integrated tool for enhancing situational awareness in oil pollution response operations. The tool facilitates planning and response, aiming to minimise the harm to maritime ecosystems in the case of an accidental oil spill. The Next-Generation SmartResponse Web tool integrates a module for predicting oil outflow from a damaged vessel with the operational SeaTrack Web platform to predict the oil drift, linking this also to the environmental sensitivity of the marine areas.



**Pentti Kujala**

**Professor**

Aalto University

Tel: +358 400 878145

[pentti.kujala@aalto.fi](mailto:pentti.kujala@aalto.fi)

[http://mecheng.aalto.fi/en/research/marine\\_technology/](http://mecheng.aalto.fi/en/research/marine_technology/)

[www.twitter.com/penttikujala](https://twitter.com/penttikujala)



# Towards healthy and productive seas with strong marine biodiversity

Hans Bruyninckx of the European Environment Agency (EEA) explores climate change and marine biodiversity in this insightful article

**M**arine biodiversity, the global climate and our economy and social wellbeing all depend on healthy seas. Despite some improvements, our assessments show that the way we currently use Europe's seas remains unsustainable. Climate change and competition for natural resources add extra pressures on the marine environment. European policies and measures could result in greater improvements when they are implemented through an 'ecosystem-based management' approach and are supported by a global ocean governance framework.

Europe is surrounded by oceans and seas, which, throughout history, have shaped its climate, economy and society. The sea has provided jobs to coastal communities and nutritious food across Europe. Maritime trade routes have brought goods along with new ideas and innovation, while ocean currents transport heat from the tropical regions towards the poles, making the climate in northern Europe more suitable to human settlement.

In fact, oceans cover about 70% of our planet's surface and they play a key role in sustaining life on Earth. They are home to a multitude of species and habitats, and every year, new species and habitats are discovered, each with unique characteristics. In addition to regulating the global climate and supporting biodiversity, oceans are also the largest carbon sink. They capture carbon dioxide from the atmosphere and help tackle climate change. They also provide job opportunities. According to the European Commission, the 'blue' economy represents roughly 5.4 million jobs and generates a gross added value of almost €500 billion a year.

## Seas under pressure

Unfortunately, oceans, including those around Europe,

are under growing pressure from human activities and climate change. Recent assessments clearly indicate that marine ecosystems are being degraded or are changing. Climate change induced temperature increases, and potential ocean acidification can further weaken the ecological resilience of Europe's seas.

A large part of the pressures arises from activities at sea, such as the extraction and production of natural resources (minerals, fish, shellfish, etc.), transport and energy production, or pollution, including discarded fishing gear.

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**"Seas are part of our European natural capital and their protection and exploitation require a European and ecosystem-based management approach, which need to go beyond sector-specific measures."**

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For example, intensive bottom trawling causes physical damage to the seafloor, damaging habitats. Or ballast waters introduce alien species, which can affect entire ecosystems, in particular in regional semi-closed seas like the Baltic Sea and the Black Sea.

Land-based activities – such as the use of agricultural fertilisers and industrial chemicals, and wastewater – add to the pressures. For example, industrial fertilisers contain chemicals like phosphorus and nitrogen, which upon reaching the marine environment act as a nutrient causing, among others, algal blooms. This excess growth in algae can deplete the oxygen in the water, whereby suffocating other aquatic species.

Similarly, plastic packaging and microplastics used in personal care products reach oceans through wastewater systems and rivers. Plastics get fragmented and small pieces are mistaken for feed by many marine species and can be fatal. They even enter our food

chain. Global and European demand for raw materials and other resources entices countries and companies to explore new opportunities beyond terrestrial and coastal zones, which could mean additional pressure on the marine environment.

### Blue economy in Europe

Recognising both the ecological and economic importance of Europe's seas, the EU has put in place a range of policies and measures, related to planning and regulating the sustainable use of Europe's seas covering many activities such as fisheries, offshore energy production, and protection of marine biodiversity.

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**“Europe is surrounded by oceans and seas, which, throughout history, have shaped its climate, economy and society. The sea has provided jobs to coastal communities and nutritious food across Europe.”**

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The Marine Strategy Framework Directive, adopted in 2008, aims to ensure coherence between such EU policies and sets three goals for Europe's seas: to be 'productive', 'healthy', and 'clean'. These efforts are aligned with the EU's Blue Growth agenda – a long-term strategy to support sustainable growth in the marine and maritime sectors, which is accompanied by the Maritime Spatial Planning Directive. The EU policy in this domain is also aligned with the Sustainable Development Goals, Goal 14 and Goal 6 in particular.

Based on the data available, the EEA assessment 'State of Europe's seas' concluded that although Europe's seas can be considered productive, they cannot be considered healthy or clean. Nevertheless, there are improvements in some areas. For example, EU Member States have already designated more than 9% of their seas as marine protected areas. Similarly, the pressures on fishing and nutrient loading seem to be easing. Despite these improvements, however, the way we use our seas remains unsustainable and threatens not only the productivity of our seas but also our wellbeing.

### European and global efforts

Seas are part of our European natural capital and their protection and exploitation require a European and ecosystem-based management approach, which need to go beyond sector-specific measures. Many of the pressures are linked to unsustainable consumption and production patterns or land-based human activi-

ties or demands. Given this, improving municipal waste management (fewer plastics in nature) or switching to cleaner transport modes (lower greenhouse gas emissions) can help the marine environment as much as improvements in sustainable practices in fisheries.

In recent years, EU policies, such as the circular economy package, the climate and energy package and low-carbon strategy, have increasingly been moving towards comprehensive approaches to tackle wider socio-economic and environment-climate challenges.

In the context of the marine environment, a comprehensive approach would entail adopting ecosystem-based management and bring together different governance forums within the EU, such as those under the Common Fisheries Policy, Maritime Spatial Planning Directive and the Marine Strategy Framework Directive.

As in many other global challenges such as air pollution and climate change, ensuring the health of Europe's seas also requires a global approach. To facilitate global cooperation and to address issues linked to global ocean governance, the European Union hosted the 2017 edition of the 'Our Ocean' conference in Malta in October. At this occasion, the European Environment Agency and the European Commission also presented WISE-Marine, a platform for sharing information on the marine environment at European scale to support ocean governance and ecosystem-based management. ■

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**Hans Bruyninckx**  
**Executive Director**

European Environment Agency (EEA)

[www.eea.europa.eu](http://www.eea.europa.eu)

[www.twitter.com/euenvironment](https://www.twitter.com/euenvironment)

# Training a global biodiversity workforce for the 21st century

Director of University of Florida Biodiversity Institute, Pamela S. Soltis gives a compelling insight into the world of biodiversity and the importance of training the workforce behind it

**B**iodiversity – the extraordinary variety of life on Earth – is fundamental to a healthy, sustainable planet, yet the connections between biodiversity, ecosystem function and services that contribute to human well-being, such as the flow of fresh water and pollination of crops, are less well understood.

Global responses to societal problems arising from the biodiversity crisis (that is, the loss and alteration of biodiversity) suffer from a myriad of problems, ranging from limited access to requisite data to inadequate policies for sustainable use of natural resources. The ongoing assembly of global biodiversity data into computer-accessible formats in publically available repositories (such as GenBank, GBIF (the Global Biodiversity Information Facility), iDigBio (Integrated Digitized Biodiversity Collections), the Atlas of Living Australia, the U.S. National Ecological Observatory Network (NEON) and many others) provides burgeoning resources to address significant biodiversity-related issues in novel ways.

Moreover, sophisticated software and cyberinfrastructure – such as computational and storage clouds, machine learning techniques, workflow platforms for data analysis – are expanding the storage and analytical requirements of a new biodiversity science that is inextricably linked to informatics and data science.

However, the global workforce is generally unprepared to take advantage of these recent developments in data assembly, software design and cyberinfrastructure implementation. Innovative training that combines biological knowledge with data science and informatics is needed to produce a workforce capable of shaping the biodiversity science of the future, as well as meeting the societal needs of a changing planet.

The promise of integrative, data-rich, computational approaches for understanding and conserving biodiversity has never been greater or more attainable. However, most professionals and students alike lack the expertise needed to access and synthesise the wide gamut of resources needed for integrative analyses.

The need for graduate training geared toward rapid changes in biodiversity science and aligned with new developments and changing workforce needs were identified by the American Institute of Biological Sciences in 2015, in a report entitled, “Addressing Biological Informatics Workforce Needs”.

That report noted that students are often interested in training at the nexus of biology and data infrastructure, but few programmes are available, and this training gap is a key factor limiting the integration of relevant data and the development of sustainable knowledge. Programmes

to fill this gap and provide synthetic training while stimulating innovative, cutting-edge research is needed.

Addressing the societal problems posed by the biodiversity crisis requires an integrated research and training agenda. Central to this agenda is the development of synthetic conceptual and technical frameworks for understanding the factors that dictate the distributions of species and allow for predictive modelling in the face of climate change. Coupled with this enhanced approach to understanding biological diversity is the design and deployment of robust data science and informatics toolkits for management, analysis, integration and storage of biodiversity data and knowledge.

This marriage of biodiversity and data science will provide critical skill sets for an empowered, 21st-century science and engineering workforce to tackle our hardest challenges for global use of natural resources, with applications to human health and agriculture. Leveraging resources and connecting biodiversity scientists and engineers via an integrated training programme can hasten the development of a workforce to enable the next generation of integrative biodiversity science.

Finally, a successful training programme requires that the products of innovative science should be made available and actionable by the broad-



est community of users, thus emphasising the significant role of communication to scientists, managers, policy makers and the public. In contrast to the classic view of a biodiversity scientist in muddy boots in a jungle, the next generation of biodiversity data scientists will be equally comfortable exploring the jungle, discussing biodiversity theory, developing statistical and machine learning techniques and optimising code for high-performance computing platforms.

The University of Florida (UF) Biodiversity Institute, in partnership with the UF Informatics Institute, has initiated an integrative graduate training programme in biodiversity and data sciences to meet the needs described above. Coursework and research, coupled with real-world experiences such as collaborative practicums and internships, form the core of this programme, which also provides training in communicating with multiple stakeholders.

Partnerships with other institutions and with undergraduate programmes engage diverse participants and extend this new vision of biodiversity science to other disciplines. Fellowships funded by the UF Biodiversity Institute enable students to focus on synthetic research at the intersection of biodiversity and data sciences. Although rare, other programmes uniting biodiversity and data sciences are also springing up elsewhere.

Moreover, many of the skills needed for integrative research can be obtained via short courses, 'boot camps', workshops and webinars, such as those offered by Data Carpentry ([www.datacarpentry.org](http://www.datacarpentry.org)), Software Carpentry ([www.software-carpentry.org](http://www.software-carpentry.org)) and iDigBio ([www.idigbio.org](http://www.idigbio.org)). Global collaboration to develop and implement next-generation training in biodiversity science is both encouraged and necessary if we are to meet the societal challenges ranging from food security to invasive species to response of species to climate change.

The UF Biodiversity Institute was introduced in the August 2017, issue of *Adjacent Government*. Launched in 2016 to bring together scientists, social scientists and policy experts to address critical societal issues of the 21st century related to biodiversity, the interdisciplinary UF Biodiversity 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. Newly synthesised knowledge from the Institute is available to individuals and organisations seeking validated biodiversity information.

Previous articles in this series have (1) introduced the UF Biodiversity Institute

and (2) described how iDigBio, the U.S. national centre for digitisation of natural history collections, promotes digitisation of collections, serves digitised data (including images and other media) for biodiversity research and education, enables the use of digitised data in biodiversity science and engages with biodiversity resources worldwide. Upcoming articles will focus on the role of the UF Biodiversity Institute in applying data science and informatics to biodiversity-centred problems and case studies of how biodiversity scientists are addressing societal problems.

Supported by the UF Biodiversity Institute.



**Pamela S. Soltis**  
**Director**

University of Florida Biodiversity Institute  
University of Florida  
Gainesville, Florida 32611, USA  
Tel: +1 352 273 1964  
[psoltis@flmnh.ufl.edu](mailto:psoltis@flmnh.ufl.edu)  
<https://biodiversity.institute.ufl.edu/>



# Polar science communication: From North to South

A group of seasoned experts from the UK Polar Network shed light on the wonders of polar science communication from North to South

The Earth is currently experiencing rapid changes in climate, driven by the anthropogenic emission of greenhouse gases into the atmosphere. The polar regions are uniquely sensitive to global warming, which has motivated polar scientific research and widespread communication of these issues to the public.

The UK Polar Network (UKPN), a national branch of the [Association of Polar Early Career Scientists](#), is a volunteer-run organisation that began in 2007.

The UKPN aims to provide education and outreach focused on the polar regions to young people and the public, as well as improving networking and support for early career polar researchers. With over 700 members, the UKPN is passionate about communicating polar science with the hope of enthusing and inspiring young people, as well as raising awareness of how these regions will change in the future.

Furthermore, through the UKPN network, early career researchers are presented with unique opportunities, such as our upcoming UK-Russia workshops, which aim to showcase the UK's excellence in polar research and strengthen collaborative research that will address challenges in the rapidly changing polar regions.

## Priorities for polar science communication

The UKPN communicates a wide breadth of polar research through discussion of proactive steps towards protecting the polar regions, rather than focussing on the negative perspective. The key challenge for the polar regions during the coming decades is how they will be altered by climate change.

For example, the Arctic is already experiencing extensive sea ice loss and may have ice-free summers by 2030 [Rosen, 2017]. This will not only affect animals, such as

polar bears, but also indigenous Arctic communities which are often overlooked. The UKPN aids in communicating these issues faced in the Arctic, Antarctic and terrestrial ice caps, whilst aiming to provide knowledge on what we can do as individuals to reduce fossil fuel emissions and protect these vulnerable regions.

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**“The UKPN plans to keep communicating polar science and inspiring young people in the hope of continually raising awareness for the polar regions, inspiring the next generation of polar scientists and promoting steps towards a more sustainable, low-emission future.”**

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The UKPN also aims to inspire young people to engage with polar research, by sharing first hand our stories of life as polar researchers, such as getting the chance to see amazing wildlife and landscapes whilst based at isolated locations such as the Antarctic Halley research station. Successfully communicating the relevance of polar science topics can be challenging. By offering this personal perspective, the UKPN hopes to encourage wider public interest in these remote, hostile environments which can often seem disconnected from our day to day lives.

Furthermore, most of education and outreach is undertaken at events where interested people sign up and therefore reaching new audiences is a significant challenge. This is a priority for the UKPN going forward and we continue to promote polar science through school visits, science festivals and Reddit question and answers style events.

## Polar research in school curricula

In recent years polar science has been in the spotlight and has captured the imagination and curiosity of young people, no doubt helped by the NERC 'Name our

Image: © Emma Smith



*Antarctic flags designed by Roding Valley High students and carried to Antarctica by Emma Smith from the Alfred-Wegener-Institute*

Ship' competition and the rise of 'Boaty McBoatface'. Interest in the new polar Research vessel (to be named RRS Sir David Attenborough) also led to the launch of the [Polar Explorer Programme](#).

More recently Frozen Planet, Blue Planet 2 and the calving of the giant Iceberg A-68 off the Antarctic ice sheet has further raised the profile of the polar regions. This has increased public awareness of polar issues, as demonstrated by the UKPN led Antarctic flag programme which doubled in size from 2016 to 2017, sending over 600 Antarctic flags designed by school children to Antarctica from 100 schools worldwide.

Polar science can be utilised to explain underpinning concepts in STEM to students in fascinating and applied ways. The UKPN carries out school visits across the UK and has compiled a list of resources for polar science education within schools. The UKPN is also in the process of creating free interactive [resources](#) such as a polar food chain game that can be easily downloaded and a soundscape called 'Sounds of Change: Greenland Ice Sheet Melt' - which provides a dramatic and intriguing perspective of life and research on the ice sheet.

The UKPN plans to keep communicating polar science and inspiring young people in the hope of continually raising awareness for the polar regions, inspiring the next generation of polar scientists and promoting steps towards a more sustainable, low-emission future.

If you want to get involved with the UKPN or want more information, then [visit the website](#) or email [president@polarnetwork.org](mailto:president@polarnetwork.org). ■

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## Chelsey Baker

PhD Student, University of Southampton

## Dr Anna Belcher

Ecological Biogeochemist, British Antarctic Survey (BAS)

## Dr Sammie Buzzard

Post-doctoral researcher, The Department of Earth Sciences, UCL

## Kyle Mayers

PhD student, University of Southampton

## Archana Dayal

PhD student, Department of Geography, The University of Sheffield

UK Polar Network

[polarnetwork.org](http://polarnetwork.org)

[www.twitter.com/UKPolarNetwork](https://www.twitter.com/UKPolarNetwork)

# Assessing climate change in the Arctic

Norwegian Polar Institute's Director Jan-Gunnar Winther highlights the challenges associated with climate change in the Arctic and its global impact

It is a fact that no region of the planet is experiencing more dramatic climate change than the Arctic. In recent years, this has resulted in melting glaciers, rapid ecosystem changes, diminishing sea ice, and changes in the atmospheric circulation and ocean properties. Ocean temperatures are increasing due to global warming. The Arctic is undergoing changes unknown to have occurred during the last 1,450 years (Intergovernmental Panel on Climate Change (IPCC), 2013). Climate models project that the most pronounced warming in the future will happen in the Arctic. In a business-as-usual scenario for greenhouse gas emissions, temperatures may increase by 8 to 10 degrees Celsius. Even in IPCC's most aggressive scenario for cutting greenhouse gas emissions, the Arctic will warm with several degrees and in turn fundamentally change this region as we know it today.

## Global impact

The Earth's regions are connected by circulation in the atmospheric, ocean, climate and weather patterns. Arctic climate change therefore has profound global consequences and affects global conditions such as sea level rise, ocean acidification, permafrost thawing (which releases potent greenhouse gases) and changing weather patterns, such as the monsoon. Arctic climate change is therefore arguably relevant to the weather and climate in regions distantly located from the Arctic.



Photo: Allison Bailey/Norwegian Polar Institute

*The lipid-rich zooplankton Calanus Glacialis is an important source of nutrition for seabirds and fish in the Arctic*

Although the development is disturbing, climate change also provides some advantages. Increased biomass production in the northern waters – not at least in the highly productive Barents Sea – may become an important resource for the world's ever-increasing need for food and proteins. Furthermore, the Arctic's special role in global change makes it a potential laboratory for developing new green technology and new solutions that may be utilised in a global context, under the idea that: What works in the Arctic will work elsewhere.

The opportunities in an Arctic with much less summertime sea ice are numerous. New shipping lanes, increased commercial fishing, new

bioprospecting activities and harvesting marine ingredients for bio-production (including organisms at lower trophic levels in the food web and at greater depths,) are among the main gains from the situation. Oil, gas and minerals are other resources that may be possible to exploit increasingly further north in the near future.

## A call for knowledge

However, today's rapidly changing climate and the major ecosystem changes that go with it, impose a fundamental challenge for management: the system is highly dynamic with large seasonal changes. We must avoid making decisions and investments for the future based on yesterday's situation. This calls for a





Photo: Jon Aars/Norwegian Polar Institute

*Female polar bear between ice floes in the Barents Sea*

continuously updated knowledge base and sophisticated earth system models to project future changes.

Also, we experience a northward expansion of marine species from the south. The fishing fleet has recently taken advantage of this development and fishing grounds are relocated northwards into the shelves of the Arctic Ocean, especially in the North Atlantic region.

This raises the question whether we may experience commercially viable fisheries in the Arctic Ocean in the future. The area of the Arctic Ocean beyond 200 nautical miles of Canada, Denmark/Greenland, Norway, Russia and the U.S is 2.8 million square kilometers. Up to now, scientists have documented an increase in zooplankton biomass over some areas of the continental shelf. However, scientists raise doubts about whether the same

will happen over deep water in the central Arctic Ocean. An important limiting factor for increased production is available nutrients, which are much lower in abundance in deep water than over the shelves.

When the Arctic marine systems become warmer, expanding pelagic fish stocks will likely migrate into the Arctic Ocean to utilise the short peaks in production there, but will likely retreat to the more productive shelves when the peaks decline. Thus, most of the fisheries in the Arctic Ocean may be confined to the shelves. As a precautionary action to avoid illegal, unreported and unregulated fishing (IUU) in areas beyond national jurisdiction, the 5 Arctic coastal states signed an agreement in July 2015 where they agree to not fish in this area. Furthermore, a scientific research and monitoring programme was established in order to obtain more knowledge in support for future management. The longer-term goal is that other countries also commit to withstand from IUU-fishing in this area.



Norwegian Polar Institute  
Tel: +47 7775 0500  
post@npolar.no  
www.npolar.no



# 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

## Adaptive Radiation of Antarctic Notothenioid Fishes

➤ Major groups of fish taxa disappeared at ~40 mya.

➤ Rise of the notothenioid fishes :  
➤ ~45% of all species in Southern Ocean;  
90-95% of fish individuals on continental shelf.

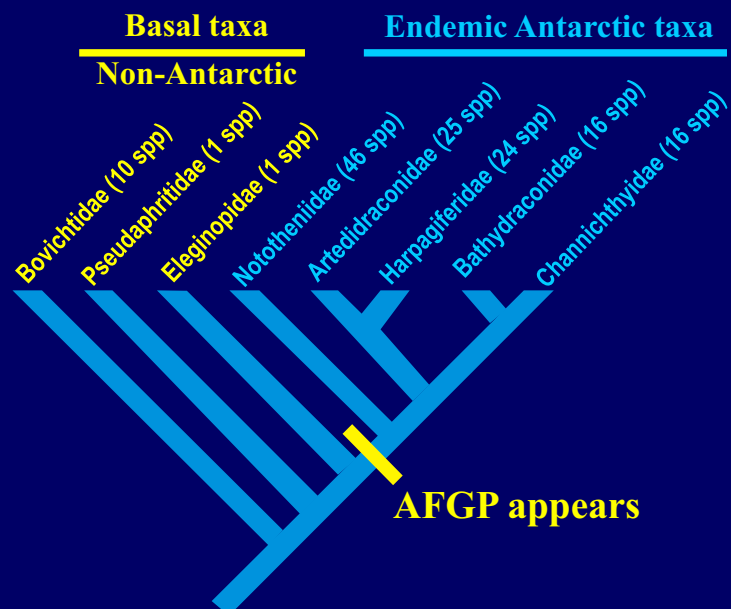


Figure 1. Cladogram of Antarctic fishes of the Suborder Notothenioidei and characteristics of the group

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 its 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.

**I ILLINOIS**

**Arthur L. DeVries**  
Department of Animal Biology,  
University of Illinois  
Tel: +1 217 333 4245  
adevries@life.illinois.edu



# A continued focus on improving Swedish energy policy

Sweden's Minister for Policy Coordination and Energy, Ibrahim Baylan speaks to us about the importance of a sustainable Swedish energy policy

**T**he goal of Swedish energy policy is: "to ensure, with as little environmental impact as possible, a secure electricity supply for companies and households at competitive prices." (1) We were fortunate to interview the country's current Minister for Policy Coordination and Energy, Ibrahim Baylan about his ambitions to make Sweden ahead of the game when it comes to implementing energy efficiency measures.

The interview kicks off when we ask the Minister about his goals for energy policy in terms of environmental impact and security of supply for companies and households. We also picked up from the conversation that the Government of Sweden's planned energy efficiency measures are both ambitious and exciting, as the Minister goes on to reveal.

"Energy should be sustainable, secure and affordable for all. Electricity in both the long- and short-term is something the Government of Sweden is making increasingly reliable and as such, we plan to move to 100% renewably generated electricity by 2040. There is an agreement from 80% of the Swedish Parliament to make this target the number 1 goal of the Swedish electricity system.

"Energy efficiency measures are essential for Sweden to achieve its energy policy objectives, which is the historical experience of the Government of Sweden. Normally, politicians focus on the production side, such as in the US where they are now focussing on coal. In Sweden, we have focussed on wind and hydro power, so from our perspective, it is equally important to focus on energy efficiency. This is a proven cost-

effective way to provide the industry and households with energy, without needing to increase the production.

“In terms of where Sweden is now compared to the 1980’s – we have 25% more inhabitants and our gross domestic product (GDP) has grown by 100% – but we are using less energy and electricity today. This proves that it is possible to combine both the development of a modern welfare society and the decreased use of energy, a work which the Government of Sweden will continue to intensify.”

## Looking to renewable energy

The conversation then moves to the exciting plans the Government of Sweden has for investment in renewable energy, increased energy efficiency and climate advisory services.

“Sweden and the other Nordic countries, especially Norway are focussed on a path unlike many other countries, in that we have tried to implement a policy that doesn’t choose technologies. The shared green certificate system is in place, which aims to support the development of renewable energy and as such, in June 2017 we set new targets in Parliament concerning renewable energy.

“We have also expanded the target for new renewable energy by 80% during the term of the current government. Sweden has ageing nuclear plants, so that is one of the main reasons why we are expanding such support. The shared green certificate system is supporting both hydro and bioenergy and it is consistently hitting its target, in a very efficient way. Consumers in Sweden are paying one-tenth of what those in Germany are spending, so we are very happy with the shared green certificate system here.”

Minister Baylan then proceeds to outline the Government of Sweden’s plans to achieve 50% more efficient energy use by 2030 and what measures are required around this. The Minister also lifts the lid on the increased support his government is giving to solar power as a form of renewable energy.

“We tasked the Swedish Energy Agency to look at all the sectors of society to see what can be done and what kind of investments are required, from both the public and the private sectors. One example is a target that says we must change all lighting in Sweden by



Image: © Kristian Pohl/The Government Offices

*Ibrahim Baylan, Minister for Policy Coordination and Energy*

2020, which will save the amount of electricity equivalent to a nuclear reactor. As the Minister for Policy Coordination and Energy in Sweden, I am very excited by this prospect of getting such concrete measures from relatively easy actions.

“The Government of Sweden has increased and implemented several kinds of support for solar energy, such as tax deductions, investment loans and support schemes as part of the shared green certificate system. We have also recently made it easier, by trying to simplify the administration around such assistance. The latest proposal we have presented to the Parliament will ensure that the budget for investment support for solar power will increase by 800-900%.

“However, the problem is that we need electricity the most during the winter months. What will ensure that

*Continued on page 317 →*





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## **CONTACT**

Andy Jowett  
Editor  
[ajowett@pbctoday.co.uk](mailto:ajowett@pbctoday.co.uk)



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solar plays a big role in Sweden's energy system is utilising energy storage, so that we are not always dependent on the sun. Storage can take the form of heated water or batteries, and when it becomes truly cost-effective it will have potential to be a part of Sweden's future energy system.

"During the summer, our consumption of electricity is around 13,000 MW and that increases to 27,000 MW in the winter. The capacity we have for hydropower is around 16,000 MW – but while we do need investments in solar energy during the winter when there is less sun – if we store the excess energy collected during the summer and move it to other seasons then no other form of energy could compare with this."

This insightful and thought-provoking interview concludes with Minister Baylan sharing his government's goal to be the first totally fossil free welfare society in the world.

"There has been heated debate for some time concerning combining economic development with a sustainable way of providing energy. There has been tremendous development today concerning electrification, wave optimisation and the development of renewable power. In this vein, we are taking the first

steps in terms of combining a strong economy with a sustainable way of providing our citizens and industries with more renewable energy.

"The Government of Sweden has set a target for the country to become the first totally fossil free welfare society. If you said this 5-7 years ago, then nobody would have believed you. Today, however, that is achievable with the best economic structures in place and I believe it is manageable for society and its citizens. ■

1 <http://www.government.se/government-of-sweden/prime-ministers-office/ibrahim-baylan/>

**Ibrahim Baylan**  
**Minister for Policy Coordination and Energy**

Government Offices of Sweden

Tel: +46 8 405 10 00

<http://www.government.se/government-of-sweden/prime-ministers-office/ibrahim-baylan/>





# Healthy food and environments for all people in Sweden

SSEC (Swedish Surplus Energy Collaboration) focus on their exciting and successful work concerning the production of both healthy food and environments for all people in Sweden

**S**SEC (Swedish Surplus Energy Collaboration) is a research and development programme at the Swedish University of Agricultural Sciences, that began on 17th December 2012. The original intention of SSEC was to take advantage of surplus heat from the Swedish industry to produce both healthy food and environments for all people.

## Healthy food and environments

However, this has been developed to apply primarily to all other residual flows in today's modern society, from surplus heat to surplus of carbon dioxide, an excess of food waste and

organic matter. Also, infrastructure, such as leftover industrial complexes, airports and even freshwater revenues all play an important part in SSEC's valuable work.

Today, the programme works with two sub-programmes that integrate on several levels, including both urban food and urban health. The programme was spread over a few sites across Sweden, but today our work encompasses 10 places in the country from Härnösand in the north to Malmö, in the south. Six of these sites focus on developing industrial food clusters, in detailed-planned areas, ranging from 50 to 130 hectares.

These industrial clusters develop something that the world has not witnessed before, namely completely circular, symbiotic and scalable food production, primarily fish and vegetables in urban environments. Certainly, we are in the very early stages of this exciting development, but substantial investments have already been made in this respect. At least one of these sites has benefitted from investment in the multi-million-dollar bracket. SSEC is, therefore, playing a part in truly building a new Swedish food industry based on Swedish primary production.

Previously, we thought that Swedish primary food production could not



compete in the international market, but this proved to be wrong in several ways. One fitting example of this concerns new advanced technology and intensive production methods as well as systems, with which we can create competitiveness far into the future.

The overall objective of the programme is that at least three full-scale, innovative fish or vegetable production facilities are launched during the 2016 to 2018 business cycle. We have no doubt that this goal will be achieved during 2018.

## The long-term strategic goals of SSEC

The long-term strategic goals of SSEC can be summarised as follows:

### Urban food, developing a viable industry

SSEC enables a new Swedish, intensive, circular and symbiotic primary production of fish and vegetables in both urban and industrial environments, under the concept of "urban food".

### Urban health, creating healthy living environments

SSEC enables new, healthy living environments for people in urban environments, under the term "urban health".

## An example of success

In Härnösand, which is probably Europe's only and true aquaponic production of tomatoes and fish, has been established in both a brand-new facility and company. The company is called Peckas Naturodlingar (Natural Farms), more details of which can be found at <http://www.peckas.se>.

**"The original intention of SSEC was to take advantage of surplus heat from the Swedish industry to produce both healthy food and environments for all people."**

## Concluding remarks

At the time of writing, Pecka Nygård himself is 85 years old. For over 20 years, Pecka has developed his unique form of technology. During the last 4 years, SSEC has been heavily involved in helping to realise this unique company, as have many others, not least the two entrepreneurs Hugo Wikström and Daniel Brännström. Of course, Pecka and his technology are the main reasons why the company exists today. So, congratulations must go to Pecka Nygård for his undoubted success.

Above is a picture of the premises at an industrial site in Härnösand, where heat is supplied from a local district heating company. 750 people visited



*Håkan Sandin*

the site the 30th November 2017, when Peckas Naturodlingar was opened. It looks like a traditional greenhouse but consists of a combined production of fish and tomatoes, an industrial symbiosis.

**SSEC** SWEDISH SURPLUS  
ENERGY COLLABORATION

**Håkan Sandin**

**Programme leader**

The Swedish University of

Agricultural Sciences

Tel: +46703168920

[hakan.sandin@slu.se](mailto:hakan.sandin@slu.se)

[www.slu.se/en/](http://www.slu.se/en/)

[www.sse-c.se](http://www.sse-c.se)



# Can the UK be a global leader in battery storage?

Senior market research analyst at BSRIA Ltd, Henry Lawson provides an expert perspective on the potential for battery storage in the UK today

In a speech in November 2017, the UK Energy Secretary Greg Clark set out an apparently ambitious vision of UK energy policy in general and for battery energy storage in particular. What is more, the UK's Faraday Challenge comes with a promise of £246 million to boost expertise in battery technology.

While the UK has generally been one of the leading advocates of a greener, more sustainable energy policy over the past few decades, it has always been more ambivalent when it comes to committing significant sums of hard public cash. While just under a quarter of a billion pounds is still modest compared to the R&D budgets of some of the world's leading corporations (Amazon alone is set to invest roughly 50 times that sum in overall R&D in 2017), it nonetheless represents an important step forward.

Battery storage matters of course because, based on current knowledge, it offers the most efficient and practical way of converting energy into a form where it can be stored safely, and in a limited space (an important factor for buildings, especially for homes) and then be available for instant use "on demand". Given that the key renewable energies, wind and solar, are inherently irregular, this form of storage is crucial to their development.

Clark's stated aim is no less than "to ensure that the UK is the place in the world where new battery technology especially in combination with the auto sector is not just developed but is commercialised".

Experience suggests that individual countries can indeed emerge as leaders in innovative green technology in a way that not only helps the environment but also makes a major contribution to their economy. Denmark, for example, has emerged as a global giant

in wind-power technology, helped not just by an abundance of wind – which many countries enjoy – but by leadership in the development of the requisite technology.

In 2016, over 32,000 people were employed in the Danish Wind Power industry – which would be proportionately equivalent to over 350,000 jobs in the UK. The industry also generated €5.98 billion in product exports, which equates to over €1,000 for every man, woman and child in Denmark.

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**"Battery storage matters of course because, based on current knowledge, it offers the most efficient and practical way of converting energy into a form where it can be stored safely, and in a limited space (an important factor for buildings, especially for homes) and then be available for instant use 'on demand'."**

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Looked at today, the UK has its work cut out to become a global leader in battery storage. In a list of "43 Battery Storage Companies to Watch" compiled by cleantech-nica in early 2015, only one company (RES) was headquartered in the UK and fewer than one in five were European headquartered – with Germany, perhaps not surprisingly, having the strongest European base. Two-thirds were based in North America and about one in six in Asia (that is in Japan, China or South Korea).

Bloomberg has projected that China's share of global lithium-ion battery production will rise from an estimated 55% today, to as much 65% in 2021. The UK, like the rest of Europe, has some reason to be concerned that, with energy storage as with so many other disruptive new technologies, so much of the main action is taking place in other parts of the world, with Europe and the UK potentially side-lined to the ranks of spectators and followers.



However, two important caveats should be applied here. The first is that there is a well-established global pattern of R&D being focused in the leading developed economies (such as North America, Western Europe, Japan and South Korea) with mass production being outsourced to countries such as the BRICS economies, especially China, India and Brazil.

The second is, of course, that an economy that optimises the use of energy storage will be about much more than the design and manufacture of ever more efficient batteries, important though this is. The creation of an energy grid which can make optimal decisions about when to store energy (at national, local and community level) and from which sources will also be critical, as will be the development and implementation of building energy management solutions which can ensure that each building manages its energy, including energy storage, in an efficient way.

Efficient support for electric vehicles and their integration into the wider energy grid where practicable will be a further key plank.

The UK government's approach, including promoting initiatives from universities, also makes a lot of sense, given that many of the world's energy storage leaders started life as offshoots of university research programmes.

All of this may or may not propel the UK to the kind of leading role that it aspires to. It is, however, a timely and much-needed move to become more proactive in one of the technologies that will be vital in creating a safer and more sustainable future. ■

**Henry Lawson**  
**Senior market research analyst**

BSRIA Ltd  
Tel: +44 (0)1344 465 600  
[bsria@bsria.co.uk](mailto:bsria@bsria.co.uk)  
[www.bsria.co.uk](http://www.bsria.co.uk)  
[www.twitter.com/bsrialtd](https://twitter.com/bsrialtd)

# Deregulation and innovation: evidence from the electricity industry

Giacomo Valletta from EDHEC Business School sheds light on the key issues concerning deregulation and innovation in the European electricity industry

Over the last three decades, the electric industry has changed enormously in terms of deregulation and innovation. Many western Governments have undertaken reforms to break apart and privatize monopoly utilities, (usually state owned, particularly in Europe) and allow retail businesses to sell electricity directly to consumers.

Even when full deregulation of the market hasn't been either feasible or desirable, "restructuring" has allowed competition in certain areas that aren't natural monopolies, such as generation and retailing.

Quite relevantly, this separation has made it possible to "make a unit of electricity into a tradable commodity with a price set by relations between supply and demand rather than by a regulator"<sup>1</sup>.

## Electricity providers

Today, in many developed and developing countries, households and businesses can shop around for the best deals on electricity, sometimes, in the same way as they shop around for a phone provider.

The intensity of reforms has varied across countries. France, for instance, has liberalised its electricity sector (in accordance with the requirements of EU directives) removing the monopoly rights of the state company EDF. Furthermore, the French Government's involvement in energy companies has progressively decreased.

Likewise, the restructuring process has led to a separation of the different stages of the production process, the establishment of a regulator and of a mediator, to protect electricity (and gas) consumers<sup>2</sup>.

Yet, despite these changes, France is among the countries whose electricity sector is "less competition-

friendly" than the OECD average<sup>3</sup> because it is still subject to a relatively heavy regulatory burden.

In light of such a variation, one may wonder to what extent the process has paid off, so far. Is it time for countries who have not yet fully embraced this path, to push further on the restructuring agenda?

## Delivering cheap energy

Intuitively, introducing market forces seems the best way to deliver reliable, cheaper and cleaner energy. Without a doubt, meeting all these objectives, at the same time, certainly requires new ideas: The International Energy Agency considers innovation as: "central to meeting climate mitigation goals while also supporting economic and energy security objectives".

However, from both a theoretical and an empirical perspective, the effects of deregulation on innovation, in the electricity sector, are more difficult to grasp than the effects on prices and cost efficiency.

If deregulation increases competition and the restructuring process involves a tightly regulated market, then firms may have an incentive to innovate, to differentiate themselves from their rivals.

However, if competition becomes "too strong", the incentives to innovate may be hampered by higher price volatility and tighter margins (which may both, at the very least, move the focus onto shorter term R&D), and by the fact that imitation may become more profitable than innovation. Also, the empirical evidence about the relationship between innovation and deregulation is rather mixed.

A recent study by Marianna Marino (ICN Business School), Pierpaolo Parrotta (ICN Business School) and

Giacomo Valletta (EDHEC Business School)<sup>4</sup> attempts to solve this puzzle by tracking the effects of major changes in the legal and regulatory framework (which were designed to dramatically lower regulation intensity) on the number of patents, used as a measure of innovation, in the electricity sector.

The aim was to progressively compare countries that have gone through major reforms with those whose electricity market remains essentially regulated, to identify and separate the direct effects of the reform on innovation from any type of pre-existing trend.

It appears that two forces are at play. In general, liberalisation does foster innovation, but a further decrease in regulation intensity, after a major reform, has the opposite effect (if the reform increases the degree of market contestability). These two relationships, however, depend on the regulatory environment in which the reforms take place.

In countries where an intense liberalisation process has already taken place, further loosening of the regulatory burden, after a major reform, decreases the number of patent applications. The opposite happens in countries who lag behind in the restructuration process.

These results match the descriptive evidence about the relationship between innovation and the intensity of regulation. This relationship is positive when regulation intensity is high (to put it another way, deregulation fosters innovation if the market is tightly regulated), it reaches its peak at some intermediate level of regulation intensity and starts decreasing afterwards (deregulation hampers innovation once the market liberalisation process is already fairly advanced).

This may have interesting implications for policy. As far as innovation is concerned, aiming for a middle ground may be a better option than pushing the liberalisation process too far, especially in the long-term.

Even if, in the short term, a drastic liberalisation process may yield positive effects in terms of production efficiency and price reduction, the risk of stagnation in innovation may be particularly problematic in light of the fact that demand for electricity is set to grow considerably in the next few years, together with the need to drastically increase the use of more sustainable ways to produce it.

Image: © Hervé Thouroude



**Giacomo Valletta**

In fact, the decision between market forces and regulation is not a dichotomous one. The complexity of an industry that mixes pure market elements with the public good, and natural monopoly characteristics, probably calls for a combination of both to provide those involved with the right incentives to find innovative ways to produce and distribute electricity.

Alternatively, another way to reach the “desirable” amount of innovation could be to use fiscal incentives, but their design can be very complicated and yield further distortions in the market. ■

1 Bakke, G. (2016). *The Grid*. Bloomsbury, USA.

2 OECD. (2016). *Fossil Fuels Support: France*

3 <http://www.oecd.org/eco/growth/indicatorsofproductmarketregulationhomepage.htm>

4 Marino, M., Parrotta, P., & Valletta, G. (2017). *Electricity deregulation and innovation*. BETA Working Paper, 2017-33.

## **Giacomo Valletta**

### **Associate Professor**

EDHEC Business School

Tel: + 33 (0)3 20 15 45 00

[giacomo.valletta@edhec.edu](mailto:giacomo.valletta@edhec.edu)

[www.edhec.edu](http://www.edhec.edu)

[www.twitter.com/edhec\\_bschooll?lang=fr](https://twitter.com/edhec_bschooll?lang=fr)



# CCS answers

## How CCS can help to eliminate CO<sub>2</sub> emissions

For every gram of CO<sub>2</sub> emitted by human activity, we are consuming decisive time, crucial to minimise our undeniable impact on Earth's equilibria. The desirable scenario is to rely on renewable energy, hoping its fast implementation throughout the world. In a more realistic scenario, CCS implementation (CO<sub>2</sub> capture, transport, utilisation and long-term storage) is an indispensable parallel effort.

Only a combination of strong energy policies and research for implementing no-emissions technology, promoting energy efficiency and fully developing CCS will allow the transition towards a decarbonised economy.

Political commitment and funding frames supporting CCS account remarkable milestones already. Among these, the Paris Agreement, the European SET Plan and the 2020 and 2030 Climate-Energy packages, to lower EU's greenhouse gas emissions 20% by 2020 with respect to 1990, and 80 to 95 % by 2050. The Framework Programmes for research and technological development (FP and Horizon 2020) and other international initiatives have enabled RD&D on CCS.

Still, there are several challenges to overcome at the different stages of the CO<sub>2</sub> value chain. A major one is making CCS economically attractive over time. Business models and opportunities are currently unclear or underexploited. Besides the main



business areas for the core technologies, additional services for the practical implementation are not yet designed or developed.

Part of the reason is that CCS still needs substantial RD&D efforts to better assess economic parameters. A lack of sufficient political and legal frames and low social and industry awareness also contribute to the sense of uncertainty. Thus, larger joint efforts are needed from governments, industry and research actors to establish new market opportunities, promote social awareness and actively support CCS development.

On the technological side, there are remaining gaps that need to be solved to make CCS a reality. At present, there

is no unique capture technology that is economic and suitable for all industrial sectors and for any location. Besides, the readiness levels vary considerably among the alternatives. Solvent-based technologies have been validated at large scale. Few of them can reach commercial scale in the short-term, though their investment and operation costs still need further reductions. Research on advanced solvents, membrane and adsorbent-based processes are showing encouraging progress.

Also in parallel, formerly less mature concepts are breaking in strongly with the latest advances. Among them, technologies based on solid looping cycles (e.g. calcium and chemical looping, Sorption-Enhanced Reforming for hydrogen production with CO<sub>2</sub> capture)

are turning into realistic alternatives. Hence, to a different extent, all these routes need additional RD&D for wide deployment at full scale.

**“Only a combination of strong energy policies and research for implementing no-emissions technology, promoting energy efficiency and fully developing CCS will allow the transition towards a decarbonised economy.”**

Once captured, a small fraction of CO<sub>2</sub> will be diverted for utilisation, expected to contribute to reduce emissions to a quite limited extent. Meanwhile, the fate of most CO<sub>2</sub> will be safe storage for thousands of years. Thus, CO<sub>2</sub> needs to be transported to the storage sites through pipelines, ships or tankers. Large-scale transport of reasonable dry and pure CO<sub>2</sub> mainly from CO<sub>2</sub>-doomes in USA has been done for decades with satisfactory results, i.e. with no critical corrosion problems.

However, CO<sub>2</sub> captured from fossil-fuelled sources might contain flue gas impurities that have not been transported before and could trigger corrosion. It is also regarded a challenge to design and to operate a CO<sub>2</sub> network connecting many point sources to offshore storage sites. To ensure safe transport of CO<sub>2</sub>, there is a manifest need of more experimental data and better flow assurance models.

## Storing CO<sub>2</sub>

Finally, geological storage of CO<sub>2</sub> in underground reservoirs has shown to be a viable technology. However, experience at the existing pilots revealed issues related to induced seismicity, visible surface uplift or pressure build up. It is still needed better understanding and quantification of various geo-

logical processes that may arise from the injection of high-pressure fluids into underground reservoirs.

Upscaling existing storage pilots will require adequate geo mechanical assessment to limit risk. Improved characterisation of candidate reservoirs is also an important prerequisite for establishing new storage sites. Besides, experience in long-term safety of CO<sub>2</sub> storage is limited at present and should gain deeper scientific knowledge. The risk of CO<sub>2</sub> leakage is another issue that needs to be considered and monitored during and after injection. The use of tracers is a well-established method for monitoring water and gas in oil reservoirs and has proven to be effective to obtain information about well-to-well communication, heterogeneity and fluid dynamics. However, the behaviour of CO<sub>2</sub> in a reservoir is more complex and still requires additional research efforts.

In summary, readiness of capture and transport technology, adequate geo-mechanical assessment and monitoring of short-to-long-term CO<sub>2</sub> storage have progressed considerably, but need further RD&D to launch large-scale CCS projects in the coming years.

Norway has a strong potential to become the leading supplier of CCS technology in Europe. The competitive advantages are large storage reservoirs offshore, remarkable advances in CCS and world's leading expertise in shipping and offshore industries.

At the forefront research in Norway, the Institute for Energy Technology (IFE) is developing CCS and energy technologies at international level. Founded in 1948, with approximately

600 employees and €100 million in annual turnover, IFE is an independent foundation actively contributing for a more climate friendly energy system, based on renewable and CO<sub>2</sub>-free energy sources, with a focus on technological innovation.

We apply a broad approach towards global sustainability, combining efforts on CCS, renewables, low value raw materials, and improved industrial processes. We maintain that CCS and low environmental impact energy and industry should be prioritised, by supporting their validation throughout their complete RD&D timeline to avoid the innovation gaps frequently found at up-scaling, industrialisation and commercialisation stages.

Co-authors:

Dr. Viktoriya Yarushina (Researcher and Group Leader at the Environmental Technology Dept.), Dr Arne Dugstad (CO<sub>2</sub> center coordinator and Research leader at the Materials and Corrosion Dept.), Dr Sissel Opsahl Viig (Senior Researcher and Group Leader at the Tracer Technology Dept.), Mr Julien Meyer (Senior Researcher and Group Leader at the Environmental Dept.).



**Asunción Aranda**  
**PhD, Head of Environmental**  
**Technology Department**  
 Institute for Energy Technology  
 Tel: +47 93624893  
 suni.aranda@ife.no

# BSRIA's role in Built2Spec for reducing the building energy performance gap

**Build2Spec aims to meet EU energy efficiency targets by tackling the energy performance gap for both new and retrofit buildings. Divya Deepankar and Chris Thompson of BSRIA's Sustainable Construction Group discuss their work in this ambitious project**

The UK construction industry has long been faced by the problem of the difference between energy consumption of an asset assessed during the design stage versus what is actually consumed during operation. This is referred to as the 'performance gap'.

The energy performance gap in buildings is the difference between the predicted energy performance of a building and its performance as-built. The difference accumulates through the design and operation stage and may result in buildings using up more than double their expected energy. Performance gap issues can occur at one or more of the following stages: Briefing, design stage, construction, commissioning, handover and in-use post occupancy.

The Built2Spec project aims to deliver the ambitious objective of meeting the EU energy efficiency targets by reducing the energy performance gap for both new buildings and retrofits. The project recognises that an integrated approach in which all important aspects of a building, from the design stage through to construction, commissioning and operation, are considered and can help reduce the performance gap often reported.

In order to achieve this, the Built2Spec project will deliver a new set of breakthrough technological advances such as 3D and imagery tools, building information modelling (BIM), smart building components, energy efficiency quality checks, indoor air quality tools, airtightness test tools, thermal imaging tools and acoustic tools; all of which will be connected to a virtual construction management platform (VCMP) supporting the collection and sharing of all project data, from initial design to the delivery.

The basic idea is to develop a process that makes it

easier for the contractor on-site to achieve higher building standards without the need for an architect to inspect everything, while also allowing all associated parties to collaborate on a common platform to achieve better buildings.

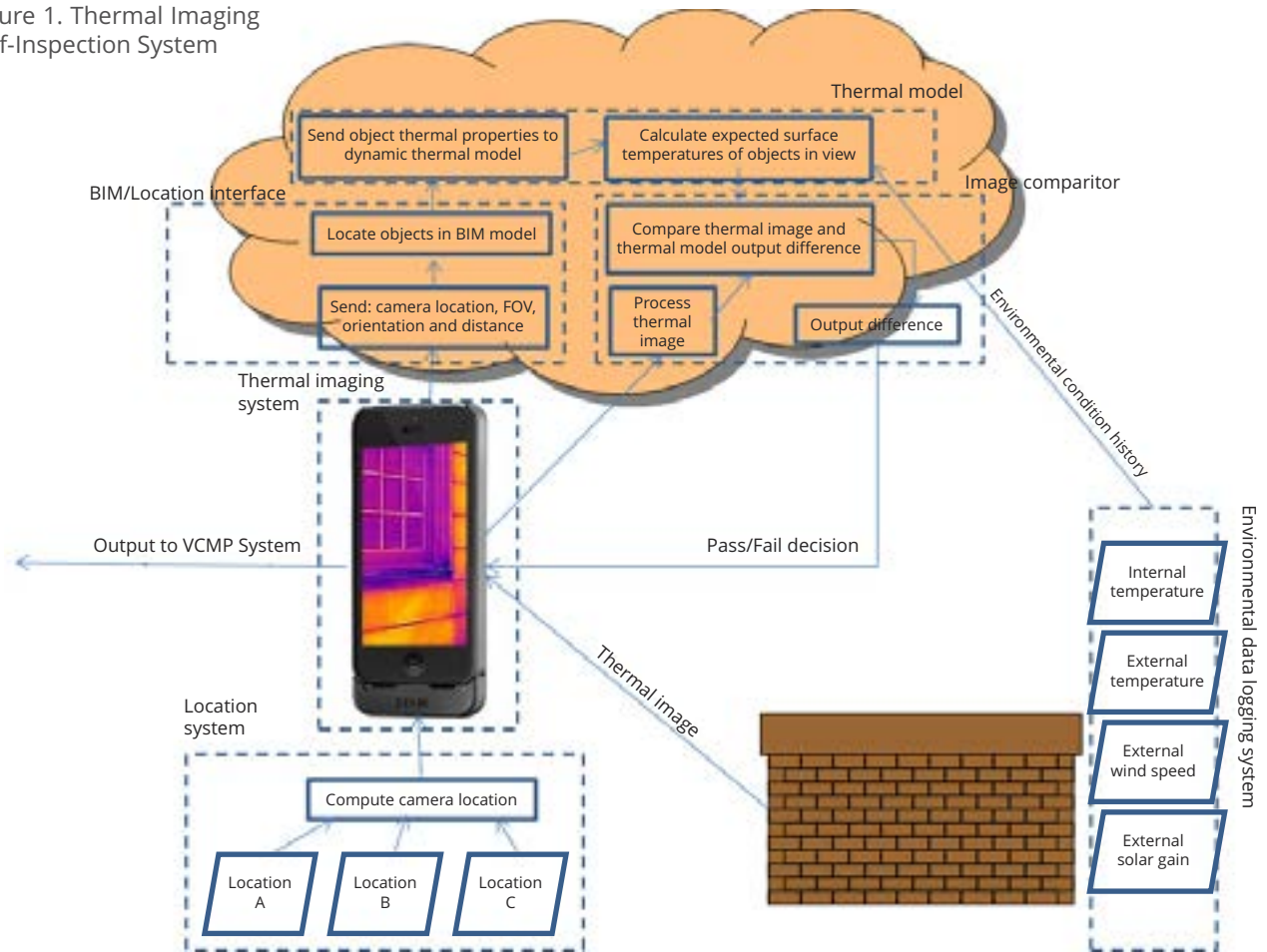
The Built2Spec project consortium involves 20 partners, with Nobatek as the overall project coordinator. The technical parts of the project where BSRIA's contribution is involved include: Stand-off U-value assessment, ie the use of thermal imaging to determine U-Value; low pressure air tightness testing; 3D model acquisition and imagery techniques; building information modelling (BIM); training and dissemination; and communication activities.

Currently, BSRIA has been involved in determining the requirements to integrate thermal inspection techniques with a VCMP system by looking at the technology involved, training specifications, systems operation and identifying potential limits for both now and in future.

The general idea is to create a platform for a construction worker with limited training to perform quality checks using a thermal imaging camera. The results would then be uploaded on the VCMP system so that the progress of construction could be easily monitored. Figure 1 illustrates this idea of the thermal imaging self-inspection system. Some of the main areas in need of development are outlined below as:

- A) Location system.
- B) Thermal imaging device.
- C) BIM and thermal modelling software.

Figure 1. Thermal Imaging Self-Inspection System



### A) Location system

The ability to determine the location of the thermal imaging camera is key to the success of the system. The system put in place to do this would need the location to be as accurate as possible, locating the position, the field of view (FOV), elevation, orientation and distance to the object being imaged.

Many systems such as Structure, Google Tango tablet devices and Bluetooth Low Energy (BLE) technology for smartphones were researched to fulfil this purpose. The BLE system would use BLE devices located around the building from which a Bluetooth-enabled device such as a smartphone could receive the signal and determine its distance from each BLE device. BLE has its limitations as it relies on comparing signal strength between beacons to estimate distances from each, but the signal strength can also be affected by building components and features that intervene and by materials that cause reflections. The BLE system's accuracy

may prove too poor to make it useful for camera location systems so it was concluded that further research would be required. Google Tango or Structure could prove useful as they can provide accurate orientation and direction due to their 3D mapping capability.

### B) Thermal imaging device

Currently, a qualified professional equipped with an expensive thermal imaging camera is essential to take good quality, high resolution images and determine what is shown in the images. Having a qualified thermographer present at multiple stages during the construction process would be very expensive. Therefore, this project explored the possibility of having a site worker take the images.

The Flir One model cameras for smartphones (Figure 2) were researched by comparing the cost, technical specification and performance with a mid-range thermal camera, the T360 from Flir. After multiple

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Figure 3. Composite Panoramic Image from Flir One

tests, it was determined that the Flir One would be suitable for basic quality checks, such as correct installation of insulation. The Flir One could also take advantage of the smartphone features, such as being able to take a composite panoramic image shown in Figure 3, along with the added functionalities of a smartphone, which would help simplify other aspects of the project such as sending and receiving images.

### C) BIM and thermal modelling software

Thermographers often have a problem in determining the building fabric composition being imaged, which could be solved by connecting BIM models and thermal images for analysis and quality inspection. With a location system working alongside the thermal imaging system, the images could be located on the building model, making comparison easier. This process could be improved further by feeding the environmental data collected on-site as input to the building model using the dynamic thermal analysis software to create a site-accurate 3D thermal model. This model could then be compared to the thermal images via location system placement; however, the software to perform these functions does not exist yet.

### The future

The Built2Spec project is advancing the boundaries of construction practices. Some goals, such as using smartphone cameras for quality inspection, may be achievable in the short-term. Others, such as implementation of a complete system which would change the process of construction management, are long-term. This will help the industry realise the potential of new technologies in construction practices by bringing

together different areas of the process of building a centralised system, leading to more efficient building construction. The implications of Built2Spec extend beyond just achieving better energy performance; it could result in a more efficient building industry shaping better buildings with higher quality standards in all aspects.

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**Divya Deepankar**

**Chris Thompson**

Research Engineers

Sustainable Construction Group

Tel: +44 (0)1344 465 600

[divya.deepankar@bsria.co.uk](mailto:divya.deepankar@bsria.co.uk)

[chris.thompson@bsria.co.uk](mailto:chris.thompson@bsria.co.uk)

[www.bsria.co.uk](http://www.bsria.co.uk)

[www.twitter.com/Energy\\_BSRIAWMI](https://www.twitter.com/Energy_BSRIAWMI)

# Is Artificial Intelligence (AI) technology smarter than your building management team?

Danny Pay, Director of Maximus Green outlines that businesses have a responsibility to adopt greener methods and use technology such as Artificial Intelligence (AI) to survive

Technology is a wonderful thing; with those small glimpses of the future from sci-fi films are now realities. We have Artificial Intelligence (AI) managing our homes and businesses and automation software streamlining every process. In fact, there is a gadget out there that can help with almost every bit of our daily lives. However, a lot of technology runs on electricity, a need which presents endless issues for those concerned with global warming, climate change and all things green. This is where the use of smart tech or green tech comes in. These energy efficient technologies claim to, but, are they actually helping? Can one technology not only replace another but actually help to save the planet as well as money on your bills?

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**“If we are going to continue using technology so that our businesses may thrive, we need to be more proactive when it comes to saving energy.”**

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A current, trending example of smart green technology is the smart meter. They're being rolled out across the country to help consumers understand their electricity and gas bills in more detail. You probably have one in your home right now. As Smart Energy GB describes:

“Everyone in Britain will be offered a smart meter by their energy supplier as part of a national upgrade to our energy system. This means the end of



estimated bills. No more having to read the meter or trying to work out your bill. No more strangers coming into your home for meter readings.”

As the old phrase goes, “knowledge is power”, so an up-to-date, clearer reading of exactly how much energy you're using and what this will cost you is very valuable. By keeping you aware of your expenditure, smart meters are showing consumers where they can cut costs, reduce their energy usage and perhaps most importantly, find ways of making their whole heating and energy systems more efficient.

Currently, a lot of business owners use smart meters and the information they provide to implement energy saving programmes and track how much they've saved, as well as help project costings for the next quarter. For energy-intensive industries, this could mean huge savings of hundreds of thousands, if not millions in fuel bills.

Smart meters are simply a small part of a larger growing industry of new technology designed to help people not only save money, but be more aware and vigilant about their energy and fuel usage.

One of the smartest switches (pun intended) one can make is installing smart lighting systems. The popularity of smart lighting systems comes from the fact that they save businesses money by cutting energy usage. The use of LED bulbs, motion sensors and a decentralised monitoring system can all help to save massive costs for not only domestic users but also commercial ones.

Smart lights turn themselves off whenever a room is left unoccupied. No more employees leaving the lights on! Imagine the energy savings a green technology system like this would have on a particularly large building or site with several buildings, especially ones





with a lot of footfall such as schools, hospitals etc. Smart lighting systems can also connect to the internet and be adjusted remotely, making sure you're always aware and in control of your lighting usage. Even if that sounds too rich for your blood, simply changing bulbs from old to new LED ones can save domestic users £240 a year on average (extrapolate that to your commercial size and see the benefit). There is so much choice and it's so easy to make improvements, you're a fool if you don't.

Another great energy saving option is smart heating systems. They have similar benefits to smart lighting systems in that they can connect to the internet (think Nest or Hive) and be adjusted remotely. You can warm up the office before you arrive and reduce the likelihood of cold, disgruntled employees. You can also adjust the heating in different areas of a building, so energy is not wasted heating vacant rooms. This

gives you more control over your gas/fuel usage and encourages your conscientiousness and vigilance over your carbon footprint.

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**"Everyone in Britain will be offered a smart meter by their energy supplier as part of a national upgrade to our energy system. This means the end of estimated bills. No more having to read the meter or trying to work out your bill. No more strangers coming into your home for meter readings."**

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If we are going to continue using technology so that our businesses may thrive, we need to be more proactive when it comes to saving energy. Even if you just want to save money, you won't go wrong by investing in smart technology that suits your needs. Businesses need technology and that need is never going to go away. In fact, it's probably going to continue increasing as businesses change and evolve alongside the technologies that

become available. Businesses then have a responsibility to adopt greener methods and use technology responsibly. I'm not referring solely to those renewable methods such as solar panels, but also to a new breed of energy efficient, green technology that comes with its own set of environmental – and monetary – benefits.



*Reducing Environmental Impacts with added Economic Benefits*

**Danny Pay**

**Director**

Maximus Green

Tel: +44 (0)1843 572 574

[dannyp@maximus-green.co.uk](mailto:dannyp@maximus-green.co.uk)

[www.maximus-green.co.uk](http://www.maximus-green.co.uk)

[www.twitter.com/MaximusGreenLTD](https://twitter.com/MaximusGreenLTD)

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# The role of the bioeconomy in Europe

Commissioner Phil Hogan recently revealed his thoughts on the role of a well-functioning bioeconomy in Europe, during a speech at Bio-based Industries Joint Stakeholder Forum

**A**t the Juncker Commission, we are convinced that a well-functioning bioeconomy can provide solutions to many of the challenges facing the EU, particularly in relation to environmental sustainability, climate action and the creation of high-quality rural jobs.

Innovative value chains within the bioeconomy can provide new outlets for agricultural products and by-products. In this way, sources of income for farmers and rural populations can be increased and diversified. This fits very well into our shared vision of thriving and resilient rural communities in Europe.

If properly managed, a modern bioeconomy has the potential to create much-needed jobs in rural areas and to contribute to more circular, climate-friendly and

resource-efficient agriculture and forestry practices. However, if we want the bioeconomy to deliver on its full potential, there are certain challenges we need to address.

The first challenge is sustainability. From my perspective as Commissioner for Agriculture and Rural Development, this means that new value chains should not jeopardise future agricultural or forestry activities by putting too much pressure on natural resources, such as water and soils.

The second challenge is inclusiveness. Today's interventions show that there is broad support for the bioeconomy, but also a variety of interests and expectations. We must make these interests and expectations converge. The bioeconomy should not



become the affair of a happy few, but benefit all the actors involved and society at large. A truly inclusive bioeconomy is one where farmers, forest owners and rural entrepreneurs receive a fair share of the value added.

This is not only a question of principle, but a key factor for delivering a successful outcome. The relevant actors will not engage and take risks; consumers will not buy products; and citizens civil society and policy-makers will not provide the necessary support unless we make the bioeconomy attractive to everybody. So, let us learn from the mistakes of the past, look at the bigger picture and build together a bioeconomy that is sustainable and inclusive for everybody.

We have had the opportunity to discover the progress made by different projects financed by the BBI Joint Undertaking. The technical progress is impressive: some advanced biorefineries have been set up in recent years and much more will follow in the immediate future. This clearly shows that we are not short of technological know-how or innovation capacity in Europe. I am aware that some challenges remain, for example, access to finance for innovative projects.

But I am convinced that technological barriers will not be the main obstacle for the emergence of the bioeconomy in Europe. Instead, I believe we should look beyond technological aspects and also pay attention to the societal aspects of the bioeconomy and to business models.

In this respect, I would like to mention 2 promising examples from organisations present here today. The Irish group Glanbia and the Swedish group Södra are members of the Bio-based Industries Consortium. They are highly innovative organisations, whose cooperative business models ensure that farmers and forest owners participate in the creation of value and receive a substantial share of the profits generated.

These are just two examples and theirs is not the only valid business model. There are many other possible approaches to engage different actors, take their expectations into account and allow them to profit from this emerging business area. All workable approaches should be explored. I would, therefore, encourage industry and the BBI Joint Undertaking to keep innovating in terms of business models as well as in terms of technology.



2017 has been a very important year for the consolidation of a bioeconomy policy in Europe. Many Member States and regions have developed their own bioeconomy strategies, inspired by the EU Bioeconomy Strategy. And, importantly, a mid-term review of the latter has been performed by a panel of independent experts.

The conclusions of this review are broadly positive and place the EU at the forefront of bioeconomy innovation worldwide. Thanks to initiatives like the BBI Joint Undertaking, the Bioeconomy Strategy has delivered in fostering research and innovation, but also in other important aspects such as raising awareness and public interest on bioeconomy and creating political momentum.

But the review also identified some areas for improvement, which we will need to address in the immediate future. Improved policy coordination is one of such challenges. I have already spoken about the complexity and cross-sectoral nature of the bioeconomy. This also has implications at a policy level. Colleagues from different Commission services and other European institutions have provided their views on this today.

In relation to the Common Agricultural Policy, I am working closely with Commissioner Moedas to reinforce synergies and coherence between agriculture and research and innovation policies. This work is taking place at a very appropriate moment, given that discussions on the next financial framework, the next Common Agricultural Policy and the next Research Framework Programme are now underway.

In the context of the bioeconomy, this policy coherence is essential, because I firmly believe that farmers and foresters should be at the heart of developing innovative solutions for the use of biological resources.

They have a deep well of knowledge and expertise when it comes to understanding what works and what does not work when it comes to primary production and it is imperative that we actively include this expertise in our strategies.

This would represent a win-win for our agri-food sector and our society, because a modern bioeconomy has the potential to create many jobs in rural areas, where they are much-needed. Estimates have shown that innovative biorefineries could create up to 400, 000



new skilled jobs by 2020, rising to 700,000 by 2030, of which 80% would be in rural areas.

We also need to do more to explain this potential to our farmers and rural communities - they need to fully understand how much they stand to gain.

In this endeavour, we are not starting from scratch – we can build on the experience of the Agricultural European Innovation Partnership (EIP-AGRI), a policy initiative that combines the resources and tools of Horizon 2020 and Rural Development Programmes to foster innovation in rural areas, with the farmer front and centre.

But policy coordination should not be limited to European policies and Commission services. In the realisation of a knowledge-based bioeconomy, the Member States, regions and even local communities play a fundamental role.

Another challenge identified in the review refers to the focus of the Bioeconomy Strategy. The bioeconomy encompasses many sectors, both traditional and novel and the challenges are numerous and diverse. It is therefore fundamental to identify the areas where the Strategy can deliver most effectively towards the policy priorities of the Juncker Commission, including the Circular Economy and our commitments on climate change.

An increased focus will concentrate our efforts on a limited number of actions where we can make a difference and produce a clear impact. And, importantly, a more focused strategy will also simplify the required policy coordination I mentioned earlier.

If this year has been important, next year will be even more so. In 2018, the Commission will shape its budget and policies for the next programming period, from 2021 to 2027. These policies will significantly influence the evolution of the different economic sectors in Europe, including of course the bioeconomy.

As regards the Common Agricultural Policy, last week we presented a communication outlining ideas on the future of food and farming. Sustainability, innovation

and diversification are central elements in this document and the bioeconomy is presented as one of the main engines that could drive European rural areas forward.

So, I fully expect that the new edition of the Common Agricultural Policy post-2020 will feature instruments capable of promoting sustainable and inclusive bioeconomy business models.

And in 2018 we should also engage in discussions among Commission services, but also with our stakeholders, to rethink the EU Bioeconomy Strategy. These discussions will be based on the findings of the review, but also on the input provided by our stakeholders in events like this forum.

Hopefully, by this time next year, we will be able to present you with the result of these discussions, in the form of a reviewed Bioeconomy Strategy, which would complete a sound, coherent and integrated policy framework for the bioeconomy in Europe. ■

This article is based on a speech given by Commissioner Phil Hogan at Bio-based Industries Joint Stakeholder Forum – 7th December 2017 in Brussels. You can read more at: [https://ec.europa.eu/commission/commissioners/2014-2019/hogan/announcements/closing-address-bio-based-industries-joint-stakeholder-forum-7th-december-2017-brussels\\_en](https://ec.europa.eu/commission/commissioners/2014-2019/hogan/announcements/closing-address-bio-based-industries-joint-stakeholder-forum-7th-december-2017-brussels_en)

**Phil Hogan**  
**Commissioner for Agriculture & Rural Development**

European Commission

Tel: +32 2 299 96 96

[https://ec.europa.eu/commission/commissioners/2014-2019/hogan\\_en](https://ec.europa.eu/commission/commissioners/2014-2019/hogan_en)

[www.twitter.com/PhilHoganEU](https://www.twitter.com/PhilHoganEU)



# Sustainable soil management challenges

Dr. Robert Simmons, Prof. Jane Rickson and Prof. Ron Corstanje from Cranfield University's School of Water, Energy and Environment sheds light on sustainable soil management (SSM) challenges, including soil degradation

**S**ustainable soil management (SSM) is fundamental to effective soil function, particularly in intensive production systems where optimal plant growth is required to deliver maximal crop yield and quality. However, across the UK and Europe, soil degradation threats such as soil compaction, erosion, loss of soil carbon and loss of soil biodiversity impact directly on key soil functions including water regulation, carbon sequestration and nutrient cycling.

Soil degradation can impact directly on yield and yield quality, as well as the timing of tillage, planting and harvesting operations. This leads to gaps in continuity which can have a significant financial impact on growers and increase their reliance on imports to meet customer requirements. This, in turn, impacts on national food security, self-sufficiency and has social impacts due to uneven labour requirements and increased food prices.

Even with moves toward reduced tillage approaches and the integration of cover crops within rotations, there is a continuing trend in the degradation of soil structure arising from highly intensive agricultural systems involving excessive and inappropriately timed trafficking, increased machinery mass, a decline in soil carbon and loss of soil biological functionality. This is compounded by increased frequency of extreme weather events. For example,

soil structural degradation in the form of compaction is widespread and pervasive. It is estimated that soil compaction effects >30 M ha of agricultural land in Europe<sup>1</sup>. The systematic degradation of soil structure can severely restrict root development and compromise the ability of crop plants to access water and nutrients, increase susceptibility to disease and pest damage with direct impacts on yield, yield quality and production costs. Addressing SSM is fundamental to European food and economic security.

## **CHaPs facilities and their role in addressing SSM challenges**

As well as containing beneficial microbiology, the soil is the reservoir for most weed seeds, insects, nematodes and pathogens leading to crop disease. The sustainable management of soil properties is therefore fundamental to the mitigation of biotic crop threats. The recent and continued withdrawal of critical chemical control measures has also rekindled interest in the role of soil management in the protection of crop health.

However, little is known of how practices such as tillage/cultivations or the use of organic amendments and crop residues affect the persistence and transmission of crop biotic threats. This lack of knowledge is hindering our ability to generate sound evidence of how soil management determines

both crop health and productivity. Guidance needs to be developed on how to manipulate soil properties that will enhance the ability of soil to suppress crop diseases and pests through sustainable soil management.

The Crop Health and Protection Centre (CHAP) Soil Health unique experimental facilities at Cranfield University provide integrated, pilot scale demonstration of the dynamic interactions between soil condition, crops, tillage, water and biotic stresses. The facility recreates the dynamic interrelationships between soil health, water use and biotic stress (pathogens, weeds and pests) and the environmental variables that influence them at pilot scale (<1 m<sup>2</sup> – 20 m<sup>2</sup>).

Controllable factors include manipulation of the whole crop production cycle (tillage, drilling, plant establishment, crop development, harvest and post-harvest), including the rotational context (multiple cropping seasons). The soil/crop/water research facilities include a 30m long 5m wide soil lane with self-propelled soil processor, rainfall simulators capable of replicating annual, as well as extreme rainfall events, a range of soil runoff/leachate slopes, crop growth cabinets and a 9m high 300m<sup>2</sup> state-of-the-art glasshouse.

Research outputs will enhance the crop-protection qualities of soil, which are fundamental for resilient and sus-

tainable crop health. Key industry challenges that can be addressed with the facilities include blackgrass control, effective use of cover and companion crops, optimising precision tillage for seedbed preparation, efficacy of cover crops to bio-remediate soil structure, identification of quality traits/crop resilience markers, screening of germplasm challenged with specific soil conditions and improved modelling of pesticide fate and resistance within soils.

## Agri-EPI and its role in addressing SSM challenges

Given global pressures on land and resources (soil, energy, water, nutrients) and growing demand for more and better-quality food, agricultural production will have to become both more intense, but also more efficient. This is particularly the case in UK, wherein a changing policy environment there is extreme competition over good agricultural land. Farming will have to harness the latest technologies to become more precise and more efficient with its resources. This is reiterated in the UK governments recently released 25-year Environment Plan. Agri-EPI (Precision Agriculture Innovation and Engineering) is a centre of engineering excellence in which innovative tools are developed for the measurement and control of variability.

Agri-EPI also provides underpinning analytical and data-fusion tools (including working with the [Agrimet-rics Agri-Tech Centre](#) and others) to analyse sophisticated sensor and image-derived data streams to create greater understanding of the extent, costs and potential causes of variation in agricultural output and manage farm resources accordingly. Current developments in innovative technology include the early detection of crop

disease, the precision application of field inputs (fertiliser, water, plant protection products) and more precise mapping of within-field soil variation.

The need for high-throughput phenotyping in plant breeding can also be addressed through the development and testing of novel sensors and image analysis protocols. Integration of these capabilities with the CHAP Soil Health facilities will allow Agri-EPI to provide advanced engineering technologies aimed at increasing efficiency and sustainability and contributing to integrated solutions for sustainable soil management, developing, for instance, cost-effective sensors to determine indicators of soil health, the next generation on-farm vehicles, informatics systems which fuse information from a variety of platforms (satellite, drones, on-farm vehicles) which will inform soil management and the phenotyping of novel crop varieties under defined soil conditions.

## Cranfield University

Cranfield University hosts Agri-EPI and the CHAPs soil management assets and has one of the largest concentrations of soil and plant science expertise in Europe, housed within [Cranfield Soil and Agrifood Institute](#), [Centre for Environmental and Agricultural Informatics](#) and [Water Science Institute](#).

Our soils expertise covers the sub-disciplines of soil physics, chemistry and biology; soil mapping and informatics; soil conservation and erosion; modelling soil processes; and soil water management and irrigation science.

We also address areas of plant and crop science and plant-microbe interactions that are critical to crop production and quality. Our research areas include agroforestry, mycology, crop water use, soil-root interactions,

grain development and storage, phyllosphere and rhizosphere microbiomes and postharvest biology and technology for fresh produce. Much of this work is underpinned by our experienced bioinformatics team.

We have a flexible approach to meet the needs of our clients and will develop research proposals in close consultation with partners from both industry and government. We also have an extensive portfolio of fundamental research funded by the research councils, underpinning and informing our applied work.

1 Akker and Canarache, 2001



## Dr. Robert Simmons

School of Water, Energy and Environment  
Cranfield University  
Tel: +44 (0)1234 750 111 ext 2761  
[r.w.simmons@cranfield.ac.uk](mailto:r.w.simmons@cranfield.ac.uk)  
[www.cranfield.ac.uk/centres/water-sciences-institute](http://www.cranfield.ac.uk/centres/water-sciences-institute)  
[www.twitter.com/CranfieldUni](https://twitter.com/CranfieldUni)

# Can Open Data Feed the World?

Jaime Adams at U.S. Department of Agriculture explores the role of open data technology and if this can help feed the whole world

Over 7.4 billion<sup>1</sup> people currently inhabit the Earth and an estimated 800 million<sup>2</sup> go to bed hungry every night – predominantly women and children. Experts tell us we currently produce enough food to adequately feed the global population<sup>3</sup>, so why do so many go to bed hungry? What steps must we take to reduce this number as the global population is projected to grow to over 9.7 billion people by 2050?<sup>4</sup>

If we are going to feed the world, we need open data policies, especially in government, to enable comprehensive decisions based on facts and evidence. This global perspective will help identify existing data and data gaps and sharpen the focus on how open data can foster innovation and collaborative research, enabling comprehensive solution sets.

What is open data and what does it mean to have an open data policy in government? Generally speaking, open data is data that can be freely used, reused and redistributed by anyone. The adoption of government policies to open government data promotes value creation, accountability and transparency. The [Global Open Data for Agriculture and Nutrition \(GODAN\) initiative](#) – comprising more than 600 international organisations representing governments, donors, businesses and not-for-profits – continues to be a leader in advocating for the adoption of open data policies. GODAN focuses on opening agriculture and nutrition data as a mechanism to support sustainable development and solve long-standing global food security challenges.

People around the world use data to make decisions every day. Although we may not see or understand all of the intricate details, we utilise vast amounts of data every day. For example, when heading out of town, most of us check the forecast wherever in the world we are travelling to before packing our bags. If the fore-

cast calls for rain, we pack an umbrella and a raincoat. If it is going to be cold, perhaps we pack gloves and a hat. How much data does a service like weather forecasting require? The National Centers for Environmental Information (NCEI) is a critical open government data source that has enabled global weather forecasting. The NCEI “hosts and provides public access to one of the most significant archives for environmental data on Earth.”<sup>5</sup> The NCEI provides over 25 petabytes of comprehensive global atmospheric, coastal, oceanic and geophysical data.

We haven’t always had the luxury of detailed weather forecasting at the tip of our fingers. Only in the last 10-15 years has technology enabled us to consume the information produced from this vast data source, through smart phone weather applications. And yet today, when we travel we may find ourselves packing food in our suitcase because we don’t know what may be available when we arrive. A farmer may not know the best market to sell their products at the best prices. A mother may not have access to nutritious food for her child or have the tools/knowledge to make better choices in selecting nutritious food within what is available. We have a global, comprehensive, open data set that enables weather forecasting, but nothing comparable to food security? Open agriculture and nutrition data is a powerful tool, critical for solving global food insecurity, yet currently, we do not have a global, comprehensive data ecosystem that spans the global farm to fork spectrum.

We can do better. The decisions made to address food security are valiant attempts to do the best with the information currently available, but we can and should do better. Ensuring that decision makers are fully informed enables good decisions. A first step would be for governments around the world to adopt and imple-





“If we are going to feed the world, we need open data policies, especially in government, to enable comprehensive decisions based on facts and evidence. This global perspective will help identify existing data and data gaps and sharpen the focus on how open data can foster innovation and collaborative research, enabling comprehensive solution sets.”

ment open data policies. Second, when implementing open data policies, FAIR (Findable, Accessible, Interoperable, Reusable)<sup>6</sup> principles should be applied. FAIR is a useful framework for thinking about sharing data in a way that will enable maximum use and reuse. A testament to the U.S. commitment to make agriculture and nutrition data available, accessible and usable for unrestricted use worldwide is the publication of U.S. government data that is continuously uploaded within the consolidated Federal catalogue at [www.data.gov](http://www.data.gov). The U.S. Department of Agriculture (USDA) has made over 800 datasets publicly available through Data.gov. USDA welcomes suggestions from the public for additional datasets to make open, this enables USDA to prioritise resources with a focus toward improved customer service.

Eight hundred million people go to bed hungry every night. If the situation does not improve and population grows as predicted, the number of people that go hungry every night may dramatically increase by 2050. By making data open and building capacity for open data use by all stakeholders, we stimulate economic growth and support farmers, scientists, consumers and entrepreneurs who are working to solve the world's long-term food security needs. If we can fore-

cast the weather around the world utilising today's available data and technologies, we have the capacity to solve global food insecurity. We need a global comprehensive data ecosystem to enable and empower us to find the right balance of solutions. ■

1 <https://www.census.gov/popclock/>

2 <http://www.fao.org/3/a-i4646e.pdf>

3 <http://www.fao.org/state-of-food-security-nutrition/en/>

4 [https://esa.un.org/unpd/wpp/Publications/Files/WPP2017\\_KeyFindings.pdf](https://esa.un.org/unpd/wpp/Publications/Files/WPP2017_KeyFindings.pdf)

5 <https://www.ncei.noaa.gov/>

6 <https://www.nature.com/articles/sdata201618>  
<https://www.dtls.nl/fair-data/>

### Jaime Adams

#### Senior Advisor for International Affairs

Office of the Chief Scientist, Office of the Secretary

U.S. Department of Agriculture

Tel: +1 202 617 4747

[Jaime.Adams@osec.usda.gov](mailto:Jaime.Adams@osec.usda.gov)

[www.usda.gov](http://www.usda.gov)

[www.twitter.com/usda/](https://twitter.com/usda/)



# Agriculture, Climate, Change

Research crop scientist from the K-State Northwest Research-Extension Center, Professor Robert Aiken explores agriculture and crop research issues in the United States today

**A**s an agricultural scientist, I consider it my duty to anticipate questions and problems which may confront farmers in the future. When I'm successful, designing and conducting effective field studies, we have the information needed to formulate feasible solutions, before problems get out of hand.

In my semi-arid region of the U.S. Central High Plains, our crop systems contend with heat stress, desiccating winds, lack of rainfall, flood-generating rains and unexpected arctic air masses, inducing winter-kill or bringing the season to a chilling conclusion. Adapting to climate change? In a sense, we prepare for climate change by helping farmers adjust to the challenges of the current growing season.

Our growers recognise long-term warming trends and shifts in weather patterns. A recent report<sup>1</sup>, prepared by the State Climatologists of Texas, Oklahoma and Kansas, indicates climate change has been written into the historical weather record. Below are three quotes from the report:

"Both temperature and precipitation have increased across the Southern Plains since the beginning of the 20th century. Temperature increases so far have averaged about 1.5°F (0.8°C) over the 20th century and precipitation has increased by as much as 5%, albeit with large variations from year-to-year and decade-to-decade. Heavy rainfall



*Rural Nebraska landscape*

events have increased in frequency and magnitude. Historical data for tornadoes and hail are not reliable enough to be used to determine whether a trend is present in these types of severe weather."<sup>1</sup>

"Variations in drought conditions from year-to-year and decade-to-decade are triggered by changes in sea surface temperature patterns in the Pacific and Atlantic oceans. The Dust Bowl drought is thought to have been exacerbated by poor land use practices, while precipitation may have been enhanced in recent decades by growth in irrigated agriculture and surface water."<sup>1</sup>

"Temperatures will continue rising over the long-term, as carbon dioxide and other greenhouse gases continue

to become more plentiful in the atmosphere. By the middle of the 21st century, typical temperatures in the Southern Plains are likely to be 4°F to 6°F (2.2°C to 3.3°C) warmer than the 20th century average, making for milder winters (with less snow and freezing rain), longer growing seasons and hotter summers. Rainfall trends are much less certain. Most climate models favour a long-term decrease, but most projected changes are small compared to natural variability. Extreme rainfall is expected to continue to become more intense and frequent."<sup>1</sup>

I have specific concerns deriving from these warming trends: declining yield potential because of increased night temperatures, diminished photo-protection systems under persistent heat

stress, increased risk of reproductive failure with heat stress at critical development stages, increased crop water requirements, degradation of soil with intensive rainfall events and increased potential for large-scale methane emissions unleashed by thawing permafrost<sup>2</sup>. These concerns rise to the top of my “watch list” for climate change impacts.

Crop productivity is expected to benefit from historic and on-going annual increases in global CO<sub>2</sub> concentrations. Assimilation rates can be maintained with modestly reduced crop water requirements. Cool-season grass crops and broadleaf crops will likely gain photosynthetic efficiencies. However, warming trends can detract from the beneficial effects of elevated CO<sub>2</sub> levels.

“When elevated temperatures exceed optimal conditions for assimilation, stress responses can include damage to the light-harvesting complex of leaves, impaired carbon-fixing enzymes, thereby reducing components of yield including seed potential, seed set, grain fill rate and grain fill duration. Field studies conducted under conditions of elevated CO<sub>2</sub> indicate that benefits of elevated CO<sub>2</sub> are reduced by heat-induced stress responses.”<sup>3</sup>

Warmer temperatures, the most reliable feature of climate change, can extend the growing season, but also impair plant productivity. Persistent heat stress pushes plant metabolism to the edge of toleration. The complexity of plant metabolic processes can be astounding. Many of these processes are temperature-sensitive, with optimum temperatures for photosynthesis ranging from 25 to 30°C (77 to 86°F) for winter wheat<sup>4</sup>, up to 32°C (90°F) for soybean<sup>5</sup> and up to 38°C (100°F) for maize<sup>6</sup>. Chronic heat stress, with daily temperatures

exceeding this range, can accelerate the breakdown of thermo-protective mechanisms and can result in permanent damage to crop canopies.

Hot conditions prior to and during flowering can result in crop failure. Grain production requires effective pollination of ovules for ‘seed set’, followed by development and growth of the kernels, harvested as grain. Excessive temperatures (i.e., daily mean temperatures > 25°C for grain sorghum<sup>7</sup>, wheat<sup>8</sup>) for a few days in the ~15-day period around flowering can decrease yield potential due to impaired pollination and seed-set; complete failure can occur with daily mean temperatures of 35°C (wheat) or 37°C (sorghum).

Night temperatures drive the metabolic rates of a plant, with the associated respiratory release of CO<sub>2</sub><sup>9</sup> as well as cell degradation<sup>10</sup>. In a sense, plant respiration depletes the supply of carbohydrates available for plant growth and development. As a long-term trend, warmer night temperatures can sap crop productivity.

Chronic high temperatures add to the evaporative demand on crop systems. This increases the water requirement for crop growth. Warmer temperatures can sap yield potential by impairing heat-tolerance protective mechanisms; by reducing the duration of grain-filling; and by increasing the respiratory cost, the water requirement for growth and the risk of reproductive failure of cereal crops. Warmer temperatures carry a complex drum-beat of warnings for crop productivity. Needed research is underway to adapt crop cultural practices to avoid heat stress; and to seek genetic advances for crop cultivars that are capable of tolerating or resisting effects of warming temperatures.

<sup>1</sup> “Climate Considerations.” John Nielsen-Gammon, Gary McManus, Xiaomao Lin and David Brown. White paper developed for “Resilient Southern Plains Agriculture and Forestry in a Varying and Changing Climate: Conference Report” July 18-19, 2017; El Reno, OK. <http://twri.tamu.edu/el-reno>

<sup>2</sup> <https://nsidc.org/cryosphere/frozenground/methane.html>

<sup>3</sup> Aiken, R. “Climate change impacts on crop growth in the Central High Plains.” Proceedings of the 21st Annual Central Plains Irrigation Conference. Colby, Kansas, February 24-25, 2009.

<sup>4</sup> Yamasaki, T., T. Yamakawa, Y. Yamane, H. Koike, K. Satoh and S. Katoh. 2002. Temperature acclimation of photosynthesis and related changes in photosystem II electron transport in winter wheat. *Plant Physiol.* 128:1087-1097.

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<sup>6</sup> Crafts-Brandner, S.J. and M.E. Salvucci. 2002. Sensitivity of photosynthesis in a C4 plant, maize, to heat stress. *Plant Physiol.* 129:1773-1780.

<sup>7</sup> Prasad, P.V.V., M. Djanaguiraman, R. Perumal and I.A. Ciampitti. 2014. Impact of high temperature stress on floret fertility and individual grain weight of grain sorghum: sensitive stages and thresholds for temperature and duration. *Front Plant Sci.* 6:820.

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<sup>9</sup> Tan, K.Y., G.S. Zhou and S.X. Ren. 2013. Response of leaf dark respiration of winter wheat to changes in CO<sub>2</sub> concentration and temperature. *Chines Science Bulletin* 58(15):1795-1800.

<sup>10</sup> Narayanan, S., P.V.V. Prasad, A.K. Fritz, D.L. Boyle, B.S. Gill. 2014. Impact of high night-time and high daytime temperature stress in winter wheat. *J. Agronomy and Crop Science* 201(3):206-218.



**Robert Aiken, Associate Professor  
Research Crop Scientist**  
Northwest Research-Extension Center  
Tel: +1 785 462 6281  
[raiken@ksu.edu](mailto:raiken@ksu.edu)  
[www.northwest.k-state.edu/](http://www.northwest.k-state.edu/)

# A call for international research and funding on locusts

Dr. Hojun Song from the Department of Entomology, Texas A&M University explores the future for international research and funding on locusts swarms in the U.S. and Europe

Locust swarms darkening the sky may be mere stories in the Bible for most people living in the U.S. and Europe, but to the people in many developing countries in Central and South America, Africa, the Middle East and Central Asia, as well as China and Australia, locusts are one of the most feared ancient agricultural enemies that have continuously threatened the livelihoods and food security for millennia. Locust upsurges and plagues still affect one in ten people on Earth, resulting in massive crop losses and costing hundreds of millions of dollars in control efforts.

Nevertheless, today there is relatively little emphasis on research and funding to study locusts. The main purpose of this article is to diagnose why locust research has slowed down in recent years and to advocate for more international collaborative efforts and funding to advance our knowledge on locusts for effective and preventative management.

Locusts are grasshoppers that can express an extreme form of density-dependent phenotypic plasticity, known as locust phase polyphenism, in which cryptically coloured, shy individuals (solitarious phase) can transform into conspicuously coloured, gregarious individuals (gregarious phase) in response to increases in population density, forming cohesive nymphal bands and adult swarms, capable of concerted, long-distance

marching and flying. There are less than 20 known species of locusts (out of nearly 6,800 species of grasshoppers), but this small number of species wreaks havoc globally.

Since Sir Boris P. Uvarov, the father of modern acridology (grasshopper research), discovered locust phase polyphenism in the 1920's, a tremendous amount of fundamental and applied research has been conducted to understand the biology of locusts. Because locusts affected many regions that were former colonies of the British Empire and the French Colonial Empire, most of what we know about locusts have come from the research centres in the United Kingdom and France. The world's first dedicated research centre on locusts, the Anti-Locust Research Centre (ALRC), was established in 1945 in London under the Colonial Office, which was headed by Sir Uvarov.

For the next four decades, the ALRC, which later became the Centre for Overseas Pest Research (COPR) in the 1970's, was the premier centre for locust research, but the shifts in government-sponsored research priorities and politics eventually led to the termination of this program in the 1990's.

In France, CIRAD (French Agricultural Research Centre for International Development) was established in 1984 to focus on agricultural research

on tropical regions around the world. In addition, its locust research unit in Montpellier was the next centre for locust research in the post-ALRC era. This unit is still active, but it too has been affected by the recent shifts in research priorities and the deteriorating funding situation in France today.

While most of the research conducted at ALRC and CIRAD had a distinctly applied angle, locusts have also been a subject of basic science research because locust phase polyphenism is such a fascinating biological phenomenon.

For the past three decades, individual university laboratories in the U.K, Belgium, Germany, Japan, Israel, Australia, China and the U.S have used locusts as a model system to study physiology, neurobiology, chemical ecology, behavioural ecology and genetics. Especially, two of the most important locust species in the world, the Desert Locust (*Schistocerca gregaria*) and the Migratory Locust (*Locusta migratoria*), have been studied in-depth in a laboratory setting and now we have a very good understanding of their proximate mechanisms of phase polyphenism.

Unfortunately, however, the number of active locust researchers has gradually become less over time as they retire or switch their fields of research. Added to this, the funding for basic science has become increas-





*A Plague of Locusts in the Judea Desert, Israel*

ingly difficult and competitive to obtain. As a result, only a handful of laboratories around the world currently focus on locust research.

Although the gradual decline in locust research is a serious issue, a more urgent issue has to do with the practical and geopolitical aspects of locust control. Many locust species inhabit remote and scarcely populated areas, which creates tremendous obstacles for their population monitoring and control. Ground locust surveys are too time- and labour-intensive and often inadequate to address the enormous spatial scale of the locust problem.

Furthermore, locusts produce outbreaks at irregular intervals and as a result, these outbreaks are often “unexpected.” Typical locust control strategies are essentially curative, consisting of large-scale applications of broad-spectrum insecticides to infestations, which is not sustainable and certainly harmful to the environment.

In addition, management of these pests is largely dependent on donor’s geopolitical interests, availability of funds, stakeholder inputs and numerous other socioeconomic aspects.

Although some locust-affected countries, such as Mexico, Australia and China, have governmental organisations for locust monitoring and control, many developing countries lack such infrastructure.

The Food and Agriculture Organization of the United Nations (FAO) has established the “Locusts and Transboundary Plant Pests and Diseases” unit that monitors and provides early warning for locust outbreaks and works with regional commissions and national authorities for locust control campaigns, particularly in Africa and Central Asia. However, recent changes in the global political dynamics could affect the future capacity to raise necessary funds to deal with locust-driven humanitarian crises.

Despite a century of research into the field, there is still a lot we do not know about locusts, while they are still menacing as ever, affecting many parts of the world. What we need to fight these ancient pests is a renewed global effort to deepen our understanding of locust biology and phase polyphenism to develop an innovative and transformative solution for an environmentally sustainable, preventative management system.

Simply speaking, we need to be able to predict in real-time when and where locusts begin to develop into the gregarious phase and specifically target and control these pests before they swarm. To realise this goal, we need improvements and innovations in remote sensing and drone technology, as well as in control methods utilising effective biological control agents and novel molecular pesticides such as RNA interference and CRISPR-based gene drives.

We also need to understand similarities and differences in the mechanisms of phase polyphenism in different locust species. These research outputs then need to be translated into a practical management scheme that can be effectively implemented by local governments and international organisations. This endeavour is understandably a hefty undertaking, as it will require a large amount of continuous funding and a complex international coordination among academia, governments and local stakeholders. However, if it becomes a reality, we will be able to claim that we have conquered the oldest and the most devastating agricultural pests of the entire human history.



## Dr. Hojun Song

Department of Entomology,

Texas A&M University

Tel: +1 979 845 2481

hsong@tamu.edu

<http://schistocerca.org/SongLab/>





# New markets for traditional cereal varieties

Bernadette Oehen and Martina Eiseltová from HealthyMinorCereals.eu shares their thoughts on new markets for traditional cereal varieties

**T**he diversity of cultivated cereal species and varieties has been severely reduced over the past 50 years. Even though there are regional differences, common wheat, grain maize and barley are the most common cereals grown in the EU, accounting for more than 85% of cereal yields and more than 78% of cereal production by area. Many of the diverse cereal species domesticated during the Bronze Age are no longer widely grown or their cultivation is declining. This is true of rye, oats, spelt, einkorn and emmer (hence referred to as minor cereals) that are part of the cultural heritage of several European countries.

The EU FP7-funded project – HealthyMinorCereals – aims to boost the cultivation and use of traditional European cereals to benefit:

- the environment, biodiversity and sustainability of agriculture;
- the economic viability particularly of small and medium enterprises (SME) and farmers; and
- the diversity and nutritional quality of cereal-based food.

Farmers today will only produce minor cereals if successful marketing can sell them. To assess their market

potential, case studies to identify successful market initiatives have been conducted in Switzerland (100,000 ha of cereal production), the Czech Republic (1.4 mil. ha of cereal production) and in Estonia (300,000 ha of cereal production).

## Czech Republic

The market analysis has focused on naked oat (*Avena nuda* L.) and spelt (*Triticum spelta* L.). Historically, spelt used to be a common cereal in the Czech Republic, mainly in the areas inhabited by German speaking people; but later, during the socialist era, it disappeared. Its revival came after 1990 and was greatly helped by

the emerging organic market in the neighbouring countries of both Austria and Germany. The experience of cultivation, processing and the marketing of spelt came from the organic market in these countries. The first seeds were imported, but soon Czechs started breeding their own spelt varieties.

**"Rye, oats, spelt, einkorn and emmer are part of the cultural heritage of several European countries perfectly suited to organic and sustainable agriculture and satisfying consumers' demands for nutritious food."**

In contrast, the breeding of naked oats has a long tradition in the country. Despite that, the production of naked oats is not very high, currently being estimated at 3,000 tonnes a year (two thirds being exported). The production of spelt is about 6,000 tonnes a year, most of which is exported.

These cases illustrate, that minor cereal production in the Czech Republic is mainly connected to organic production. PRO-BIO Ltd. is an example of a successful company involved in the development of the Czech organic market since its beginning. The company has developed a whole organic supply chain: processing facility, wholesale retailing and distribution of food products all over the Czech Republic. More recently, PRO-BIO is also active in trading seeds for organic farmers.

## Estonia

Oats (*Avena sativa* L.) is a traditional crop in Estonia, grown on about one tenth of the Estonian cereals acreage. It plays an important role in organic production. A remarkable role in the

organic oats market belongs to the farmer's cooperative Wiru Vili founded in 2009. At that time, Estonian organic farmers wanted to sell about 500 tonnes of organic oats, but none of the Estonian traders were interested.

So, farmers started to trade the cereals themselves and mainly exported it to Germany. Since 2015, the cooperative exports Estonian organic cereals to North America. The success of Wiru Vili is linked to its high product quality (the cooperative has its own quality assurance scheme) and at the same time, ensuring the best and fairest price for the producers. Thanks to the cooperation of organic cereal producers organised by Wiru Vili, Estonia is the world's second-biggest exporter of organic oats. In contrast to the well-organised export market, its domestic market remains uncoordinated.

## Switzerland

Switzerland is not a member of the European Union and protects its producers from cheap imports. The arable production and the milling sector profit from this protection. Some decades ago, spelt was the most common cereal produced in the northern and central part of Switzerland, as it is well adapted to the cold and rainy weather and low soil fertility of this region. However, in 1993, it was only grown on 1000 ha; today it is grown on 4000 ha (i.e. 3% of the arable land in Switzerland).

In contrast to the Czech Republic and Estonia, the organic sector is not the main actor in spelt production in Switzerland. More than 70% of spelt is traded by the Spelt Interest Group (IG Dinkel), founded by farmers and millers in 1995, and under their own trademark

"UrDinkel" (PureSpelt). The whole production cycle – seed production, dehulling, milling and supply to bakeries – is organised by IG Dinkel. Only two spelt varieties (Oberkulmer and Ostro) can be traded as "UrDinkel". The main producers of UrDinkel are so-called IP Suisse farmers. IP (Integrated Production) thrives on its reduced use of pesticides and implements measures to protect biodiversity.

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**Bernadette Oehen**  
Market Analysis Expert  
bernadette.oehen@fibl.org

**Martina Eiseltová**  
Project Dissemination Manager  
eiseltova@vurv.cz

**Dagmar Janovská**  
Project Coordinator  
janovska@vurv.cz  
HealthyMinorCereals.eu  
www.healthyminorcereals.eu

# The global challenge of antibiotic resistance

Roxane Feller, AnimalhealthEurope Secretary-General provides a fascinating insight into the global challenge of antibiotic resistance

Antibiotics have had very positive effects on animal health over the years. Our pets are living much longer than they were decades ago and livestock are raised much more efficiently through our ability to control bacterial disease. As with people, antibiotics play an important role in alleviating pain, treating disease and ensuring the health of our animals.

They also serve a One Health purpose, ensuring good animal health and welfare for over 600 million cows, sheep, pigs, goats and chickens in Europe, contributing to the sustainable production of safe food and helping to prevent food-borne illnesses in people. They also help to ensure that our pets remain healthy members of more 70 million pet-owning homes in Europe, contributing to the general well-being of dogs, cats, rabbits and people!

There are currently no alternatives to antibiotics for treating bacterial infections in animals. But these miracle solutions do have a 'kryptonite factor'. As warned by the pioneer of penicillin, Alexander Fleming during his Nobel Prize acceptance speech in 1945, "...the ignorant man may easily underdose himself and by exposing his microbes to non-lethal quantities of the drug make them resistant." Antibiotic resistance is recognised as a global challenge impacting people and animals alike and affecting the environment in which we live.

For the past 2 decades, the animal medicines industry in Europe has been proactively leading the charge against the challenge of resistance development on a number of different levels to try to preserve the efficacy of these precious tools. Actions are wide-ranging such as awareness-raising and promoting responsible use of antibiotics in compliance with the correct dosage and treatment length; promoting disease prevention practices; encouraging the use of diagnostics; contributing

to data collection regarding use and resistance development; providing input into policy tools; and more.

Equally important, in terms of action, is a renewed impetus for investment in antibiotic innovation – provided that new EU rules offer adequate data protection - and new solutions for managing infectious diseases, such as prevention through vaccines, immunostimulants, or novel anti-infectives for suitable veterinary use, etc. The range of different antibiotic classes approved for veterinary use is limited compared to those for human use and the last new antibiotic class approved for veterinary use was over 25 years ago. Nothing new has been developed since.

To maintain a balance in treatment options for both people and animals it is, therefore, essential to look at this from a One Health perspective. From the animal health industry's perspective, the WHO Guidelines on Use of Medically Important Antimicrobials in Food-Producing Animals published towards the end of 2017, were disappointingly lacking in this regard.

The guideline largely ignores the needs of animals in terms of health and welfare and the wider impact of healthy animals in terms of food safety, disease transmission and sustainable farming. Previous communications from the WHO state that their list of medically important antimicrobials should be revised on a regular basis in a collaborative and coordinated approach by FAO, OIE and WHO, but these new guidelines appear to largely ignore the OIE list of Antimicrobial Agents of Veterinary Importance and do not adequately look at the fundamental need for antibiotic treatment in animals.

Some recommendations appear to contradict the OIE list and such a single-focused approach is out of touch with the progress made through the EU One Health



*Roxane Feller, AnimalhealthEurope Secretary-General*

Nations 'Sustainable Development Goals' to the European Commission's Communication on the 'Future of Food'<sup>2</sup> – that more sustainable agricultural practices are central to ensuring a better future.

Even with excellent bio-security and animal husbandry on farms, or the best health management including vaccination and nutrition, some animals still become ill with infectious bacterial diseases causing disruption for the farmer, lower quality products or potentially total loss of produce, more need for inputs like feed and water and greater potential for food-borne illnesses.

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**“For the past 2 decades, the animal medicines industry in Europe has been proactively leading the charge against the challenge of resistance development on a number of different levels to try to preserve the efficacy of these precious tools.”**

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Going beyond the economic and sustainable development arguments for ensuring access to and preserving the efficacy of our antibiotics, there is a strong ethical dimension to the issue. Inflammatory conditions like mastitis, for example, are extremely painful for the animal concerned and we have both a moral and legal duty to avoid and alleviate suffering.

Keeping livestock healthy by ensuring access to use all the necessary tools, including antibiotics, means that not only are animal welfare levels higher, responding to consumer demands, but the animals produce more efficiently and provide safer meat and dairy products, the essentials of a nutritious diet. ■

1 <http://www.un.org/sustainabledevelopment/>

2 [https://ec.europa.eu/agriculture/sites/agriculture/files/future-of-cap/future\\_of\\_food\\_and\\_farming\\_communication\\_en.pdf](https://ec.europa.eu/agriculture/sites/agriculture/files/future-of-cap/future_of_food_and_farming_communication_en.pdf)

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**Roxane Feller**  
**Secretary-General**

AnimalhealthEurope

Tel: +32 2 543 7560

[info@animalhealthEurope.eu](mailto:info@animalhealthEurope.eu)

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

[www.twitter.com/animalhealthEU](https://twitter.com/animalhealthEU)

action plan against AMR and the EMA's One Health approach to the categorisation of critically important antibiotics which carefully considers the needs of animal health and welfare whilst safeguarding public health.

In the ongoing EU revision of the legal framework for veterinary medicinal products, the industry supports proposals for EU decision-making on the categorisation of critically important antibiotics to be entirely science-based, following the recommendations of EU scientific experts within the EMA. Legislative proposals that would curb the unnecessary prophylactic use of antibiotics in livestock can also be supported, provided there is no negative impact on animal health.

It is vital not to ignore the needs of animals in terms of health and welfare. And the wider impacts of healthy animals in terms of food safety, disease transmission and sustainable farming cannot be ignored either. Keeping farm animals healthy is becoming ever more important as the world population continues to grow, requiring a safe and sustainable food supply. All international and regional bodies agree – from the United



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The logo features a stylized 'A' composed of a grey swoosh and a red and yellow starburst shape.

# Agile Business Consortium

A photograph of a conference table with a person's hands holding a book titled 'AgilePfM'. On the table are also a white mug, a small potted plant with purple flowers, and some papers.

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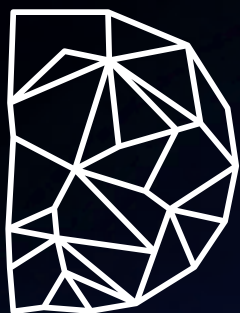
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