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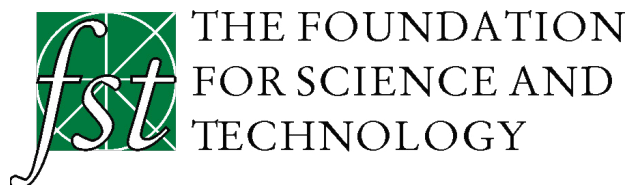
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Prime Minister sets out AI vision for healthcare transformation

In a speech at Jodrell Bank on 21 May, on the subject of science and modern industrial strategy, Prime Minister Theresa May set out her vision of how Artificial Intelligence (AI) could help transform the treatment of disease by 2030.

'AI and Data' is one of the four Grand Challenges in the Government's Industrial Strategy. The Prime Minister told the audience that "the United Kingdom will use data, artificial intelligence and innovation to transform the prevention, early diagnosis and treatment of diseases like cancer, diabetes, heart disease and

dementia by 2030. Late diagnosis of otherwise treatable illnesses is one of the biggest causes of avoidable deaths.

"And the development of smart technologies to analyse great quantities of data quickly, and with a higher degree of accuracy than is possible by human beings, opens up a whole new field of medical research and gives us a new weapon in our armoury in the fight against disease."

She set out her ambition that, in regard to cancer, "within 15 years we will be able to diagnose at a much earlier stage the lung, bowel, prostate or ovarian can-

cer of at least 50,000 more people a year.

"Achieving this mission will not only save thousands of lives" she added. "It will incubate a whole new industry around AI-in-healthcare, creating high-skilled science jobs across the country, drawing on existing centres of excellence in places like Edinburgh, Oxford and Leeds – and helping to grow new ones."

Mrs May said that specific ambitions in a range of other disease areas will be announced over the coming weeks and months.

bit.ly/mayspeech

New GCSA Vallance takes up his post



The Government's new Chief Scientific Adviser (GCSA) took up his post on 4 April. Dr Patrick Vallance succeeds Sir Mark Walport who is now the Chief Executive of UK Research and Innovation (UKRI). The role of the GCSA is to advise the Prime Minister and government on all matters related to science and technology and to ensure that policies and decisions are informed by the best scientific evidence and strategic long-term thinking.

The GCSA is head of the Government Science and Engineering (GSE) profession and Co-chair of the independent Council for Science and Technology which provides high level advice to the Prime Minister.

Before joining the Government Office for Science, Dr Vallance was President, R&D at GlaxoSmithKline (GSK) from 2012. Prior to this, he was Senior Vice President, Medicines Discovery and Development and he joined the company in May 2006 as Head of Drug Discovery.

Pilot plant sucks carbon from the air

Analysis of the performance of a pilot plant suggests that carbon dioxide can be removed from the atmosphere at a cost of around \$100 per tonne. That represents a significant advance on the current price.

The peer-reviewed report, in *Joule*, describes a process for capturing CO₂ from the atmosphere in an industrial plant. The design captures ~1 Mt-CO₂/year in a continuous process.

It notes that the capture of CO₂ from ambient air was commercialised in the 1950s as a pre-treatment for cryogenic air separation. In the 1990s, Klaus Lackner explored the large-scale capture of carbon dioxide as a tool for managing climate risk, now commonly referred to as direct air capture (DAC).

Canadian firm Carbon Engineer-

ing was set up in 2009 with funding from Microsoft's Bill Gates and Canada oil sands financier Norman Murray Edwards. Their pilot plant has been running since 2015, capturing about one tonne of CO₂ per day. The process works by sucking air into a modified cooling tower with fans, where it comes into contact with a liquid that reacts with the CO₂. After further processing, a purer stream of CO₂ is extracted and the capturing liquid is returned to the process.

A previous study carried out by the American Physical Society in 2011 suggested that the cost per tonne of direct air capture would be around \$600. But Carbon Engineering say that by adapting existing technologies they have been able to slash this significantly.

bit.ly/carbonDAC

Reclassifying cancers could aid treatment

A US-led study into tumour types investigated their similarities and differences on both a genetic and cellular level. It found that nearly two-thirds of cancer clusters with key molecular similarities were found in more than one area of the body.

The researchers believe that reclassifying them according to similarities in cancer types, rather than the current method by the initial location in the body, would be more effective. Reclassification would ultimately lead to better, more targeted treatments, they argue.

One tumour type was found in 25 parts of the body, meaning it would tra-

ditionally be treated differently depending on where it was found. The study of 33 cancer types from more than 10,000 patients found they could be reclassified into 28 clusters that shared similar molecules. The study found that common cancers, such as in the lung and breast, can be broken down into more than one cancer.

"Patients will have the best shot at successful treatment if their tumours can first be classified according to their genomic and molecular makeup," said Professor Christopher Benz, from the Buck Institute for Research on Aging in California.

bit.ly/pancanceratlas

The place of research institutes in science and innovation

Ed Hill

What will the UK science and innovation base look like as investment rises from 1.7% to 2.4% of GDP by 2027? The ambition is clear: that the UK should be the best place in the world to do science. How should the UK's research landscape evolve if it is to meet the challenges and opportunities ahead?

The creation of UK Research & Innovation (UKRI) is part of the answer. This kind of reform of the public funding landscape happens once in a generation. It will create opportunities for more strategic approaches to inter-disciplinary science, addressing national needs as well as supporting a more seamless approach to the translation of great science into business solutions (an area where the UK has historically under-performed).

Delivery

Yet changing the funding architecture is only part of the story. It is also important to examine the diverse delivery side of the UK's research and innovation ecosystem. Keith Smith's Government-commissioned report of 2015 surveyed Research and Innovation Organisations, defined as 'non-profit organisations that perform research and innovation support as their main activity, whose existence depends on a significant degree of public funding, and whose work serves a public policy purpose'. They have diverse ownership models (e.g. parts of Government, Non-Departmental Public Bodies, Government-owned companies, or charities largely funded by Government). Their functions vary:

- Public Sector Research Establishments (PSREs) are research and development institutes sponsored directly by Government Departments or the Research Councils;
- Public Research Organisations include standards-setting organisations, forecasting or mapping services and research organisations;
- Independent Research and Technology Organisations are mainly private non-profit or commercial research enterprises which provide R&D services to Government and business;
- Catapult Centres bring together business, research and engineering around innovation.

These institutions have differing research intensity (the ratio of R&D spend to total income). Research Council Institutes tend to be the most research-intensive, often managing large research infrastructures and data assets (physical or e-infrastructures) and supporting the wider university-based communities of researchers.

The majority of PSREs are sponsored by the Department for Digital, Culture, Media & Sport (Museums and Galleries). The two main foci of the remainder are Bio-Medical Sciences (30%) and Environmental & Natural Resource Sciences (35%). The influential reviews that shaped today's funding system – Lord Sainsbury's in 2007 and Sir Paul Nurse's in 2015 – were both largely silent on the role of PSREs, almost as if universities were the only significant means of delivering research and innovation.

It is true that UK universities are top-class institutions (12 of them were in the world's top 100 in 2017) and that they outnumber PSREs (130 to 58). However, Research Establishments play complementary roles and there are significant funding flows through them. Of the £25 billion R&D spend in 2010, 9% went through PSREs, 26% through universities and 65% through private sector organisations. Nine purposes of Research Council Institutes were articulated in the 2002 review of Research Councils and these were reiterated in 2007 by the House of Commons Science and Technology Committee (see Table 1). That articulation still holds good today.

Overseas experience

The use of research institutes as a major mode of research and innovation delivery is prevalent in countries such as China and Korea. However, it would be a mistake to infer that Government-funded research institutes are associated only with economies in developmental stages, and that advanced market economies place less reliance on them with research and innovation delivered instead by the private sector or through



Professor Edward Hill is Executive Director of the National Oceanography Centre (NOC), part of the Natural Environment Research Council (NERC). The Centre's remit is to provide a national capability for large-scale oceanographic sciences, from coastal to deep-ocean. Professor Hill has served on a number of national and international advisory bodies including the International Steering Group of the Global Climate Observing System (GCOS), the European Marine Board (EMB), the cross-Government UK Marine Science Coordination Committee (MSCC), the Governing Board of the National Centre for Ocean Forecasting (NCOF), as well as NERC's Executive Board and Science and Innovation Strategy Board (SISB). He is currently the UK Head of Delegation for the International Oceanographic Commission (IOC). He was awarded an OBE in 2010 for services to environmental sciences.

Changing the funding architecture is only part of the story. We must also examine the diverse delivery side of the UK's research and innovation ecosystem.

Table 1. Criteria defining the variety of purposes for Research Council Institutes. Source: House of Commons Science & Technology Committee, 2007.

Purposes of Research Council Institutes	
1.	Provide a national capability and source of advice to Government.
2.	Create a critical mass of research capability, effort and expertise, to provide enhanced research productivity, visibility, exploitability or rapidly to strengthen an under-developed area.
3.	Foster coordinated and cooperative multidisciplinary approaches to a research area.
4.	Encourage a long-term research vision and strategy.
5.	Enable long-term survey, monitoring and data management activities underpinned by research.
6.	Provide a full-time research-centred environment.
7.	Open up scientific career paths and opportunities which may not be available within university or faculty structures.
8.	Develop and provide facilities and services.
9.	Allow greater investment in capital equipment and the skills of support staff, because of the more stable environment.

open innovation via universities. Large publicly-funded National Laboratories are major features of the research bases of G7 members such as the USA, France, Germany and Japan.

In Germany, the Max Planck, Fraunhofer and Helmholtz Institutes are funded primarily by the German Federal Government. Helmholtz Centres are focussed, for example, on solving grand societal challenges with a mission to:

- conduct top-level research in strategic programmes within seven research fields: Energy, Earth & Environment, Health, Aeronautics, Space and Transport, Matter, and Key Technologies;
- research highly complex systems using large-scale devices and infrastructure, cooperating closely with national and international partners.

In my own field of oceanographic sciences, no serious player in big ocean science (basin-decadal scale) attempts delivery through their university sectors alone. Without the contribution of national ocean research institutions, global cooperation would be hard to imagine at the scale that occurs. For example, these institutions have worked closely together in building and sustaining the Global Ocean Observing System and have shared access to infrastructures like research vessels.

Without the contribution of national ocean research institutions, global cooperation would be hard to imagine at the scale that occurs.

The UK's National Oceanography Centre plays a key role in sustaining the health and national-scale critical mass in key ocean science disciplines (e.g. physical oceanography) which would be difficult to sustain in universities. In common with the top half-dozen oceanographic institutions, it has major ocean measurement technology developed to high Technology Readiness Levels (leaving a much shorter step to commercialisation of products). Compared with other countries, however, the UK's national ocean institute is much more explicit in leading, coordinating and enabling participation in ocean sciences across a diverse but relatively thinly-spread academic ocean science base consisting of more than 30 universities and smaller institutes.

The UK has recently created new research and innovation institutions to meet strategic needs e.g. the Crick Institute (biomedical science), the Alan Turing Institute (big data analytics) and the Catapult Centres (which are focussed on three-way industry-Government-academic partnerships to accelerate innovation in critical business sectors such as advanced manufacturing and space).

The last survey of knowledge transfer activities in PSREs in 2014 showed strong performance against a set of eight metrics and found, "on a per-institution basis, PSREs exhibit higher values than Higher Education Institutions ... Overall, despite the challenging economic and funding environment and with less traditional stimulus put in place by PSREs to reward knowledge transfer and commercialisation, i.e. performance rewards for inventors, PSREs appear to have delivered more outputs in five out of the eight sci-

ence and innovation indicators, with particularly impressive results in relation to spin-outs and income from commercial activities.”

Recognition

Although less visible and more muted than in other countries, research institutes have some recognition in the UK. In its inquiry into Research Council Institutes (a subset of PSREs), the House of Commons Science and Technology Committee in 2007 concluded that “Research Council Institutes (RCIs) form an important part of the UK science base. They make a unique contribution in terms of providing national capacity and access to facilities and in developing multi-disciplinary science driven by a clearly-defined mission. The RCIs often come into their own at times of emergency due to the ability of their Directors to respond to changing demands, especially from the Government. In order to pursue their missions, RCIs need guaranteed, long-term core funding, which they may then top up with other grants and commissioned research.”

However, that inquiry also sounded a warning: “There needs to be more coordination of policy needs between those who have a direct interest in the work and health of RCIs and also greater coordination of policy towards RCIs on the part of the Government and the Research Councils and more responsibility taken for their sustainability.”

Looking forward

So why does this matter now? In common with all advanced economies, the UK faces many great challenges: demographic, environmental, economic, technological and the shift in geopolitical axes of power. Science has an immense contribution to make in addressing these issues.

A healthy and diverse science base in which complementary parts of the ecosystem can work effectively will be crucial. The UK’s departure from the EU gives this an even keener edge. The UK will need to pay even greater attention to supporting business innovation and to draw upon advice, based on world-class, authoritative scientific and technical capabilities which can bolster its interests and influence.

However, a decade on from the House of Commons Science and Technology Committee warning – a decade of flat science budget funding and cuts in Government Department R&D budgets – there are concerns about the health and resilience of some research institutes. The threats they face include: the risk of mission drift as they seek diversified income in order to survive; increasing difficulties securing scientific and technical talent under public sector pay restraint; lack of opera-



NATIONAL OCEANOGRAPHIC CENTRE

The National Oceanographic Centre’s newest research ship and the fourth of its name, RRS Discovery is a multidisciplinary vessel, specifically designed for the challenges of 21st century oceanography. It was delivered to the National Oceanography Centre on the 8 July 2013. Fitted with the most up-to-date and high-tech instruments and equipment, it is ideal for oceanic exploration. With the ability to travel to remote and extreme oceanic environments, RRS Discovery is highly sophisticated and has the ability to operate in high sea states (up to sea-state 6).

tional freedoms and slow Government decision-making – all inhibiting the ability to work effectively with business.

In a speech in 2014 Lord Willetts, then Minister of Universities and Science said, “I know from some of the conversations I have had with these institutes that some are finding it difficult to operate in the public sector. In particular, there are growing concerns among some Research Council Institutes, who feel that administrative barriers are getting in the way of great science. They want greater flexibility on pay within, of course, our overall agreed pay framework ... I believe that our science base would be substantially weaker if, unlike the USA or Germany, we proved unable to provide a regime in which a public research institute could function well.”

Investment is now on a trajectory towards 2.4% of GDP. UKRI exists with both a strategic mandate and the capacity to look right across the science and innovation landscape. It has an opportunity to take the lead, working with Government and business, in creating the science base needed to shape the future we want. □

In common with all advanced economies, the UK faces many great challenges: demographic, environmental, economic, technological and the shift in geopolitical axes of power.

RESEARCH AND INNOVATION

As UK Research and Innovation (UKRI) 'leaves the starting blocks', a meeting of the Foundation for Science and Technology on 28 February 2018 considered the issues surrounding Government funding for research and innovation.

A strategy for UK Research and Innovation

Mark Walport



Sir Mark Walport FRS HonFRSE FMedSci is the Chief Executive of UK Research and Innovation (UKRI), which is responsible for the public funding of research and innovation. He was previously UK Government's Chief Scientific Adviser and, before that, Director of The Wellcome Trust from 2003 to 2013. Until 2003, Sir Mark was Professor of Medicine and Head of the Division of Medicine at Imperial College London.

The world is changing in dramatic ways. There are more than seven billion people on the planet and this will rise to more than nine billion over the next 20-30 years. Some parts of the world, like the UK, Europe, North America and Japan, have populations that are aging. Other regions, notably sub-Saharan Africa, parts of South Asia and South America, have young populations and this disparity is driving migration.

Humanity is making an indelible impact on the planet. No-one can be unaware of the issues around, for example, plastics waste and the threat it poses to the oceans. These changes pose a whole series of 'grand challenges' which are international in scope and require multi-disciplinary solutions. Physical sciences and engineering may be part of the solution, yet without an understanding of the social sciences, i.e. how to implement the engineering in the best way, the results will not be optimal.

The world of science itself is changing, with extraordinary new research tools. There is the ability to handle datasets on a scale not possible before – thanks to some extent to the astronomers whose enquiries into fundamental questions needed the development of new techniques for processing big data.

To tackle many of the grand challenges, it is necessary to bring together biologists, engineers, physicists and mathematicians. In addition, the sheer scale of facilities like the ATLAS detector at CERN demand a pooling of resources, being too big for any single nation to undertake.

Business

The world of business is changing. There is a blurring of the boundary between manufacture and services. There is the challenge of turning waste into positive resources, sometimes called the 'circular economy', and there is a requirement to make better use of scarce raw materials.

The UK has an industrial strategy which can

SUMMARY

- Our world is changing rapidly and UKRI must respond to those changes
- The Industrial Strategy lies at the heart of UKRI's initial priorities
- Effective research programmes increasingly need to span disciplines
- The Government is committed to a target of investing 2.4% of UK GDP on R&D by 2027
- Artificial Intelligence (AI) is one of the areas where UKRI will be able to make a difference.

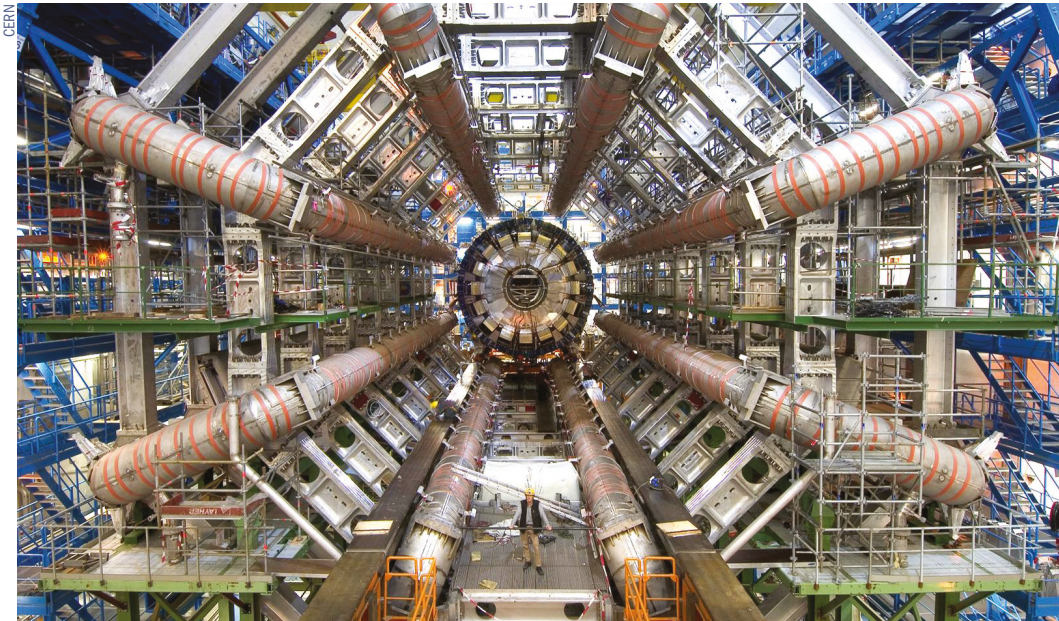
only deliver if based on the skilful use of all aspects of knowledge, from science, engineering and technology through to the arts and humanities, as well as the social sciences.

A further change is that affecting society itself. The establishment – which includes the scientific institutions – is less trusted today. Being trusted requires the public demonstration of trustworthiness, which will be an important challenge for UKRI in its public engagement. The research community may be good at talking among its members, but it will have to become very much better at talking with much broader audiences.

UKRI

UK Research and Innovation (UKRI) – comprising the seven Research Councils, Research England and Innovate UK – is concerned with delivering benefits to society. That includes economic impacts, social impacts and cultural impacts in order to help deliver an enriched, healthier, more resilient, sustainable society. To do so will mean pushing the frontiers of human knowledge and understanding.

This work must be underpinned by a well thought-out corporate plan. At the heart of our initial priorities is the Industrial Strategy. This



The sheer scale of facilities like the ATLAS detector at CERN demand a pooling of resources.

has the four cross-cutting themes of clean growth, healthy aging, future transport and artificial intelligence (including machine learning and data science in the broadest sense).

The White Paper announced about £750 million for a second wave of industrial strategy challenges. These are industrial in origin, where application-inspired research (it may be quite basic research) can make a significant difference. And these are substantial challenges. For example, they cover how to benefit from the energy revolution, how to transform construction, how to transform food production and how to ensure healthy aging. Projects like Biobank or the 100,000 Genomes can create an extraordinary platform linking together clinical phenotypes with genetic and other data as a substrate for discovery and for industrial innovation.

There are two Pioneer Challenges with, initially, smaller amounts of funding but they will feed into bigger challenges. One is looking at the next generation of the service industries (the service sector currently accounts for 80% of our economy) while the other is investigating the role of potentially extraordinarily disruptive technology arising from the most fundamental research in the quantum sciences.

The Infrastructure Roadmap looks forward to 2030. Major infrastructure is needed for research and innovation, industry needs diamond synchrotrons and neutron spallation sources, and so we need to plan ahead. This work is being led by the Science and Technology Facilities Council (STFC). The project began last autumn and will be completed by Spring 2019. It will look at the key assets that support research and innovation, including publicly-funded and accessible infra-

structure supported by UKRI and other charitable funders for example. It will look at all disciplines. It will look at infrastructure, but also to the contribution of the arts and the humanities. Importantly, it will look at our e-infrastructure because this will underpin everything.

Innovation and commercialisation

Cross-cutting funds which span research and innovation are being deployed through Innovate UK. However, people may need help to navigate the complex knowledge-exchange funding landscape. The Higher Education Innovation Fund (HEIF) spans the dual-support system in all of the administrations of the UK and brings together the Research Councils, universities and other higher education institutes as well as Innovate UK.

UKRI and Innovate UK will facilitate 'collaborative R&D' partnerships which bring businesses together with universities and researchers. Innovate UK has a range of business-support mechanisms, including a new loans mechanism currently being piloted and, of course, the Catapult network.

International collaboration

It is more important than ever to be outward-looking across the globe. UKRI is working closely with the Department for Business, Energy and Industrial Strategy (BEIS) on international research and innovation strategy.

Within UKRI, work is progressing on cross-Council activities such as the Global Challenges Research Fund and the Newton Fund – we also recognise that we have very important partners within the national academies and the British Council. We plan to bring these international programmes together within UKRI.

There are substantial challenges: how to benefit from the energy revolution, how to transform construction, how to transform food production and how to ensure healthy aging.

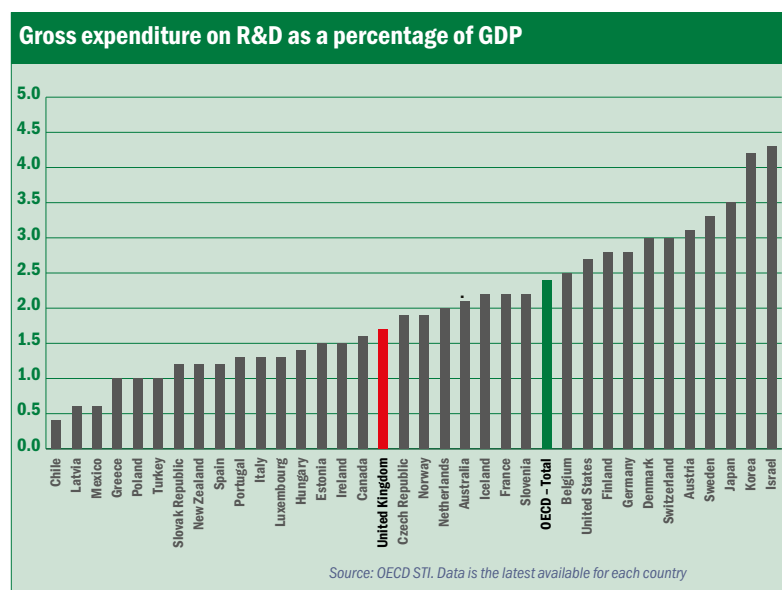


Figure 1. In 2015 UK's expenditure on R&D represented 1.7% of GDP – below the OECD average R&D intensity of 2.4%.

The power of 'place'

Place is an important topic at the moment. UKRI is developing a £115 million fund called 'Strength in Places'. This is not to create something where there is nothing, but to recognise that excellence is widely distributed across the UK. We need to build on excellence in business and industry in particular places, bringing in the associated excellence of local HE institutes and local government support as well.

Where that confluence can be achieved, there is the potential to build further and establish a cluster. Science and innovation audits have been helpful preliminary exercises, so the next task is to support emerging R&D strength and grow the capacity.

Strategic Priorities Fund

The SPF builds on Sir Paul Nurse's vision of a common fund, supporting high quality strategic R&D priorities which might not get through the current systems. We will use this to catalyse work with communities and identify interdisciplinary challenges that do not fit readily into existing programmes.

Through the National Productivity Infrastructure Fund (NPIF), UKRI will be investing £300 million over the coming three years in encouraging world-class talent, supporting new cohorts of PhDs and knowledge-transfer partnership positions as well as funding specific investment in AI.

Artificial Intelligence is a very good example of a field where UKRI can make a difference. To make the most out of AI, the computer scientist and the mathematician must understand how to develop their research along with lawyers who are thinking about this area, philosophers who are pondering it and historians who are looking back at previous

industrial revolutions. We will therefore look to create interdisciplinary PhD programmes that will bring together communities to work together in this field. There may be other areas where a similar approach would be productive.

UKRI will need to work with Government Departments on their policy questions. The fact that Departments are now publishing their areas of research interest offers a catalyst for us to have those discussions and for the research community itself to identify important questions that society wants to address. This touches on health, wellbeing, resilience and security.

Investment

The Government has announced that it wants to invest 2.4% of GDP in R&D by 2027 – the average across the OECD. There is a longer-term target of 3%.

An additional £7 billion has been committed for research and innovation, of which a significant fraction will be channelled through UKRI by the year 2021-22. The UK is only near the middle of the OECD rankings (see Figure 1, above) but given the return achieved, we do seem to be spending the investment effectively.

Among the challenges addressed to UKRI since its formation was announced are the following:

- it should bring research and innovation together while retaining their distinctiveness;
- Research Councils must continue to attract high quality leaders;
- governance should respect the autonomy of the component parts;
- the new organisation should be a strong advocate to Government.

And UKRI is responding. It is delivering the Industrial Strategy Challenge Fund, bringing together Innovate UK, the Research Councils and Research England. Seven Executive Chairs have already been appointed for the Councils. We have also attracted outstanding individuals onto the councils of each organisation.

Governance strikes a balance between the autonomy of individual Councils for matters within their natural domain while ensuring the greatest strategic coordination on cross-cutting matters.

In terms of advocacy, there is no doubt that we have had an impact in the Treasury and across Government. We are supporting the commitment to 2.4% of GDP by 2027, but it must be remembered that two-thirds of that will come from industry. This will require the strengthening and maintenance of a skills pipeline, high-quality education, the nurturing of talent and many other elements. □

Governance strikes a balance between the autonomy of individual Councils for matters within their natural domain while ensuring the greatest strategic coordination on cross-cutting matters.

Research and innovation within an ecosystem

Alan Wilson

SUMMARY

- Ecosystems share common questions and challenges
- Strategies have to take account of both top-down and bottom-up insights
- How should different societal needs be prioritised?
- Industry has to be engaged with the research communities
- Should UKRI be looking to catalyse a radical shift in research?

UK Research and Innovation (UKRI) is a key node in a complex UK – indeed international – research ecosystem. It can offer strategic direction and for many it will be a key funder.

How are the strategic priorities of an ecosystem categorised? I am a researcher who has worked in a national institute (today it is the Rutherford Lab) and as a university professor building research teams on Research Council grants. I was a founder and director of a spin-out company, a university vice-chancellor, Chair of a Research Council and, currently, CEO of The Alan Turing Institute.

In all these activities, there are common questions and challenges. There is a need to acquire a knowledge of the current landscape, decisions on where to invest resources and on how to build capacity and skills. There is also the question of how to connect a top-down strategy with bottom-up creativity. All of these are challenges for UKRI.

Where are the potential game changers in research? Some will be rooted in pure science, while others will be related to wider societal challenges, like curing cancer. Another key consideration is where knowledge can be applied. That can be used as a working definition of ‘innovation’.

A systems view

So, how to set about answering these questions? A systems view is nearly always valuable: what is the system of interest and how is it embedded in

other systems? Note that a systems perspective requires an interdisciplinary perspective.

At what scale is the research to be focussed? Any system of interest will in fact be embedded in a hierarchy of supra-systems and sub-systems.

Now, most innovation comes from the lower reaches of the hierarchy; and what is more, these discoveries can often be transferred to other domains. Take computers, for example: invented as calculating machines, they are now ubiquitous in a wide range of systems.

Contributions to strategy can come top-down from institutions (reading the landscape and horizon-scanning) or bottom-up from individual researchers.

Impact also plays an important part. Does anyone want to do research that has no impact? I doubt it, but ‘impact’ should include transformative change in and across disciplines just as much as in industry and the public sector. Perhaps, we have been too narrow in our definition of impact.

Establishing a base

These challenges, questions and approaches have to be addressed at each node in the ecosystem. Then the nodes must be effectively connected. For example, money has to flow in the direction of the potential game-changers and the high impact innovations. Each node, from the individual piece of research up to UKRI has to have a strategy, grounded in experience, but employing horizon scanning and imagination.

The ecosystem has not been functioning effectively for some time – notably in the transfer of research findings into industry and the public sector. Herein lies a particular challenge for UKRI. Its strategy has to be open to the ‘bottom up’, while incentivising Research Councils, Innovate UK, the universities, the Research Institutes and, not least, industry. It needs to do all these things if it is to have a chance of delivering game-changers and ground-breaking innovations.

Most innovation comes from the lower reaches of the hierarchy; and what is more, these discoveries can often be transferred to other domains.



Sir Alan Wilson FRS FAcSS FBA is Chief Executive of The Alan Turing Institute and Professor of Urban and Regional Systems in the Centre for Advanced Spatial Analysis at University College London. He is also Chair of the Home Office Science Advisory Council. Sir Alan was Vice-Chancellor of the University of Leeds from 1991 to 2004 when he became Director-General for Higher Education in the then DfES. From 2007-2013 he was Chair of the Arts and Humanities Research Council; and from 2013-2015, he was Chair of the Lead Expert Group for the Government Office for Science Foresight Project on The Future of Cities.

The Diamond Light Source, which opened in 2007, is one of the major science investments that will be included in the UKRI infrastructure road map.



Building a strategy

To build an effective strategy, UKRI will have to:

- identify and build on strengths and opportunities – both the people with track records and the early career researchers with skills, imagination and ambition – there is a top-down vs bottom-up aspect here;
- find ways of avoiding the conservatism of peer review which is enforced by the Research Excellence Framework. I believe that universities do not always provide the right incentives by insisting on both the volume of publication and focusing for promotion on ‘top journals’. This has skewed the motivation of researchers, particularly by neglecting applied research whose outputs do not qualify for the selected journals.

Industry has a role to play. Where are the modern equivalents of Bell Labs? How much R&D is now being done in start-ups with the big players relying on purchasing success? While there are many excellent examples of industry-university joint working, there could perhaps be many more.

Another strategic question which demands sensitive judgement relates to the size of research groups. What should be located at the ‘big science’ end of the spectrum? There are established successes, from CERN to Sanger; there are new Institutes like Turing and Diamond, with others in development. Yet is the average size of a research group in a university too small? Are there poten-

tial ‘big science’ areas that are not funded as such? Cities, for example, falls into this category.

Indeed, how do we value different fields of research for public funding? Health, education, justice – all are obviously important. Basic research is needed to support future industrial development. Should there be more applied research as well, both in industry or the public sector?

Radical shifts

In the 1950s, Warren Weaver was the Science Vice-President of the Rockefeller Foundation. He argued that systems of interest fell into three categories:

- simple;
- disorganised complexity;
- organised complexity.

Roughly speaking, the first two represented (among other things) the physical sciences of the time, while the third comprised biology. He switched his funding from physics to biology. That was a prescient decision. Is there an equivalent diagnosis to be made now?

UKRI’s strategy needs to be connected to the social questions of our time: climate change and sustainability; the future of work and incomes; growing social inequalities. Does this agenda demand a Weaver-like shift?

While I have focussed on questions specifically relating to UKRI strategy, in reality, every element of the research ecosystem needs strategic thinking: from universities and institutes, through industry and Government Departments, to individual researchers. All of it needs to be strongly connected to translational and developmental ecosystems. □

UKRI’s strategy needs to be connected to the social questions of our time: climate change and sustainability; the future of work and incomes.

Fruits of bold experimentation

UKRI has set out its statement of intent to be the world's best research and innovation agency. So, what would 'best' look like?

NESTA has spent a great deal of time examining innovation agencies around the world. It would be really helpful to have an objective 'best model', but the best research and innovation agencies are those that deliver for their own societies and economies. Historically, the most successful have constantly experimented, optimised and adapted their approach.

I want to offer four areas where I think we need to see some bold experimentation by UKRI.

The first area is finding how to speak with one voice. It means harnessing the collective experience and expertise of universities, of businesses, of other places across the country and the world. Our ability to do this is so far behind where it should be. We are not very good at drawing on the collective capacity of humans to solve problems.

The second is the issue of public engagement. This is not just important but crucial for UKRI. We find ourselves today in the early stages of profound social and economic change from the disruptive impacts of the fourth industrial revolution.

There is a significant gap between what technocrats think and what the public wants. While the public is very supportive about investment in research and innovation, our polling found that their priorities were very different from the Government's. They will prioritise health but also education – perhaps innovation in education

should be a priority for UKRI?

NESTA is offering a series of grants, looking for more creative and experimental ways to engage the public in science and innovation policy-making. The scale of UKRI really creates the opportunity to re-invent public engagement and also to set a far higher bar for evidence on what works.

The third point is how can UKRI deliver an international agenda worthy of the post-Brexit era? Lining up the constituent parts of the UK system is hard enough without considering the bi-lateral, the multi-lateral, the diplomatic, the political, the commercial agendas which come along with trying to forge international partnerships. There is an enormous amount to do to maximise the potential value of programmes like Newton and the Global Challenges Research Fund and to optimise the ways that they work.

We do not have all the answers to these issues, which is why experimentation is so important to help us understand how they can work in the future.

Without starting from scratch, how can UKRI pool the resources, the talent, the knowledge from across the system and combine them in new ways with data that 10 years ago was completely unavailable? This is not just a technology project involving big data, it is also about personnel. An important challenge for UKRI is how to engage the right talent and the right expertise, at the right time. We might learn from something like the talent cloud in Canada, which is a new system of employing civil servant expertise to feed into expert agendas. □



Kirsten Bound, executive director of research analysis and policy at NESTA, joined the panel after the formal presentations.

Building on our strengths

I have worked in technology for 35 years. I started as a research physicist and I spent some time as an engineer in the aerospace and defence industry. I am now a businessman running a part of the McLaren organisation, a UK automotive organisation which is applying technologies in other areas as well, such as public transport and health.

The challenge for the UK, as for any business seeking to be competitive on a global scale, is to build on our strengths and differentiate ourselves through the application of research and innovation. This must be underpinned by great science and a steady stream of great talent coming out of both universities and, at a skilled level, apprenticeships.

Despite the complexities of funding rounds

and the intricacies of interfacing with Government and its agencies, McLaren has had some very positive experiences, particularly through working with Innovate UK. We have just completed a new manufacturing centre in Sheffield, in collaboration with the University of Sheffield and the Advanced Manufacturing Research Centre, as well as the Catapult Centre and have received huge support from the Sheffield region.

We have also worked with the Advanced Propulsion Centre in Coventry, looking into low carbon propulsion systems. We have invested in the pursuit of high-power and high-energy battery systems, electric motor development, advanced combustion and advanced transmission systems.



Jonathan Neale, Chief Executive of the McLaren Technology Group, joined the panel after the formal presentations.

FURTHER INFORMATION

UKRI strategic prospectus – www.ukri.org/about-us/strategic-prospectus

UKRI framework document – www.gov.uk/government/publications/ukri-framework-document

Industrial Strategy – www.gov.uk/government/publications/industrial-strategy-building-a-britain-fit-for-the-future

The support mechanisms we have accessed have worked really well, but it is so difficult to get there in the first place.

I would pose two questions. First, given the changing nature of our relationship with Europe and the connections with European research insti-

tutes, how does UKRI seek to maintain and build on those links? In addition, what priority should it place on better relationships with other research institutions in other countries?

To succeed we will need a high level of innovation and execution. Governance is much more than just making sure public money is being spent wisely, it is about making things happen. Sir Paul Nurse's report alluded to the very good work done in the Research Councils, but noted that management was stretched, with the administrative burden getting in the way of making things happen. Last year's report on the Catapult centres made some observations as to why they have not been as effective as was hoped. How can UKRI better focus our research and innovation activities, and so silence the critics who say "this is just creeping bureaucratisation". It will be a huge challenge for UKRI. □

The debate

After the formal presentations, members of the audience contributed their own views on aspects of the debate including: public engagement – and public confidence – in science and innovation; international links; regional growth; skills development and diversity.

Public engagement is not necessarily a question of getting the public involved in the 'how' of research and caution has to be exercised in relation to the 'wisdom of the crowd'.

However, a revolution in public engagement with science could be energising. It could encourage a focus on interdisciplinarity, particularly in conjunction with the social sciences (as was evidenced in the Foresight programme on cities). It could also provide a platform for interpreting science to the public. Public debate in recent years had been damaged by politicians, commentators and media outlets giving credence to bad science (for instance in relation to climate change).

There is a need to create understanding that some research and innovation efforts will fail. Indeed, a negative conclusion to a piece of research can be as significant – and as worthy of recognition – as a positive one.

Science needs to contribute not only to the question of what could be done but what should be done. In the field of artificial intelligence and deep machine learning for example, where systems could be applied to operate in an unfair way, transparency is vital and ethical questions have to be addressed. Evidence reviews are important here and UKRI's role in supporting the trustworthiness of research and innovation is critical.

It will be important to support regional growth in the UK through investment in research and innovation. This does not mean reducing investment in existing centres of excellence: it is not either/or.

That science and innovation are increasingly

on the agenda of all political parties is to be welcomed; and indeed there are issues salient to science which have to be addressed at a political level, such as the affordability of innovation in areas like health. Equally, science has a vital role to play in framing issues relevant to the societal and political agenda. But UKRI has to take a view that is longer term than the usual political timescales.

UKRI has a key role in driving international collaboration and linking industry partners in the UK with wider international partnerships. A more restrictive approach to international recruitment could have severe consequences for the talent pipeline in the UK. Research and innovation, and related fields of advanced technology, are international, in terms of reach and of talent. Barriers to bringing that best talent into this country from Europe would be wholly self-defeating.

UKRI must support efforts to broaden the diversity of the talent pool within the UK. That means addressing elements of the research culture – and needs engagement at every level, from national academies, universities and schools through to direct engagement with students and parents.

UKRI should help to make the process of innovation less linear and more joined up. It should encourage interdisciplinarity globally (on issues such as climate change) and nationally; and support a diversity of funding sources.

Perhaps the biggest challenge facing UKRI is to ensure that the increased funding that research and innovation has been awarded is wisely spent, and seen to be so. □

BUILDING REGULATIONS AND SAFETY

The Grenfell Tower disaster have led to demands for a thorough review of the regulatory system covering the built environment. The scope and progress of that enquiry was the subject of a meeting of the Foundation for Science and Technology on 24 January 2018.

A radical overhaul is required

Judith Hackitt



Dame Judith Hackitt DBE FREng was chair of an independent review of building regulations and fire safety for the Government. She was Chair of HSE from October 2007 to March 2016. She previously served as a Commissioner between 2002 and 2005. She was made a Dame in the 2015-16 New Year Honours for services to health and safety and to engineering, in particular for being a role model for young women.

There is a broader agenda here than just what to do to about the Building Regulations, urgent though that is. There are general questions about the reasons one sector does not learn from what happens in another. It is not just a problem facing the construction industry. The review takes a systemic view of regulation (for URLs see p20), while focussing on the construction and buildings sectors. It examines how regulation works (or not), rather than homing straight in on quick fixes for a particular problem. It seeks the root cause of what is wrong with the system.

The review

The review itself began in July 2017 with a very tight timescale – and rightly so. It is separate from the Public Inquiry because it is doing a very different job: it is looking at the system. I am reporting jointly to the Housing Secretary and the Home Secretary. The end-to-end review is looking at fire safety systems as a whole and everyone who is part of it. To be clear, that does not mean just new-build. It covers what happens once the building is commissioned as well as who looks after it and takes care of its integrity when it is occupied and in use.

While assessing the effectiveness of the regulations themselves, the review has also focussed on how they apply to high-risk, multi-occupancy complex buildings. I am charged with making recommendations that will make for a more robust regulatory system in the future.

The two initial pieces of work were the call for evidence, where people were given a relatively short period of a month to respond to us and, at the same time, a very significant mapping exercise to lay out how the system was supposed to work.

A series of meetings for a whole host of stakeholders followed, ranging from residents to those who are involved in the regulatory and inspection process. Right from the outset everyone was saying to us: “Fix this!” Yet a quick fix is not the answer: the whole system needs a radical overhaul. Those interactions gave us strong support for the things we said in our interim report which was published at the end of the year.

SUMMARY

- A systemic view of the regulatory system is required, not just a quick fix for specific issues
- The regulatory system for the construction and buildings sectors needs a radical overhaul
- It is not enough to look just at construction methods – the way buildings are operated and managed must also be included
- The voice of the resident must be heard and the regulatory system must allow for this
- We need an outcomes-based system in which responsibilities are vested in the right people.

As an engineer who tries to look at how things work in practice, it was important to apply a systems-based approach to the review. This made it very clear why such a complex system, with so many points of weakness, has failed to deliver the right answer. It also provides some very good pointers as to what should be put in its place. I am confident that we can produce a system that is significantly simpler and more effective.

In the interim report, we said quite clearly that there needs to be a culture change. Just changing the regulations will not work unless we have the support of the people in the industry to behave differently.

The current regulatory system is not fit for purpose and has to be changed. Part of the problem is the culture of the construction industry itself but there is also the part played by those people who then take over those buildings and manage them throughout their lifecycle. There is a real concern about people doing things for lowest cost, not thinking about the real role – and that is to keep people safe in those buildings.

There are major issues about both the effectiveness of the current system of regulation and its enforcement. Enforcement powers are very limited and, in my view, provide no deterrent whatsoever.

At present, the regulations and guidance are complex and unclear. They need to be clear and to be simple – that is the direction we must take for

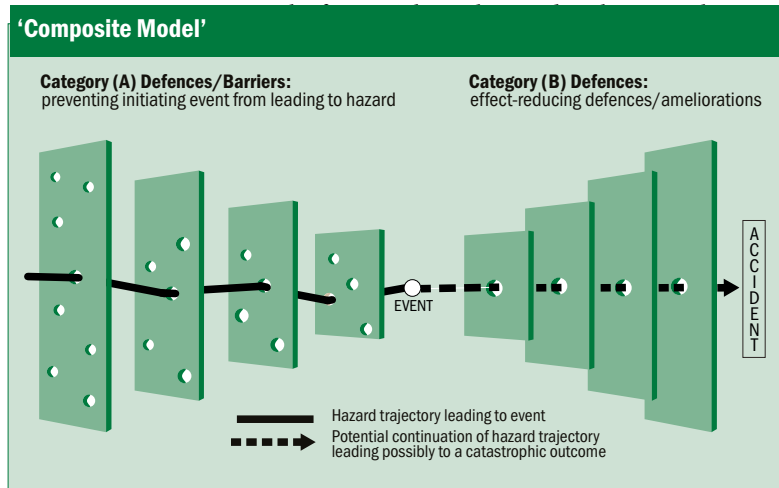


Figure 1 A whole system approach to regulation. Picture courtesy Charles Haddon-Cave QC.

who is responsible for what. The means of assessing and assuring that people involved in the work know what they are doing and have the competence for it, is weak. The product testing system is almost unworkable. Compliance and enforcement procedures, as well as sanctions, are weak. The residents' voice is hard to hear as there is no clear way for them to raise their voices and their concerns.

Given the long list of things that are wrong, there are some fundamental changes to be made in the regulatory framework. The regulatory guidance system should be geared more towards dealing with different levels of risk. We do not need the same level of oversight on simple buildings as we do on complex structures which have multiple occupancy – in particular those in which residents are vulnerable. There has to be a proportionate approach that applies different levels of oversight.

There must be clearer roles and responsibilities. Many people who spoke to the review compared the lack of clarity in the Building Regulations with the clarity in the Construction (Design and Management) Regulations – or CDM as they are commonly known.

Competence has to be raised throughout and not just in the construction industry itself. Regulators, designers and those in procurement all need to be included. People involved in procurement in this sector do not always know what they are asking for or how to manage that process effectively.

The interim report talks about the need for a golden thread running through the whole process – a clear statement of design intent. This should include what the building is for and how the process is going to be managed. It is extraordinary that what is finally built may not be what was approved at planning stage. In my industry, change control is rigorous.

We have to create a means for residents' concerns to be raised quickly and easily. Those concerns must receive an effective response. The

current system of product testing, which is designed by experts to classify materials according to many different requirements all at the same time, must be transformed. We must put in the hands of those using these materials something that helps them make good decisions easily.

A call to action was launched to industry at a Summit on 22 January. The response has been tremendous, really positive and enthusiastic. We have asked a number of different groups within industry to come and work with us in joint teams, working with members of the review, so that we can get answers together for that next and final report.

I have been using the diagram shown in Figure 1 with people in the construction and buildings sector. It is a picture of an alternative culture. Managing the risk associated with complex buildings is not about creating compartments where everyone stays in their own space. Common sense says that in a high-rise building with 200 people in it, someone somewhere is going to breach their compartment by, say, putting in broadband or knocking a hole in the wall.

Figure 1 illustrates how, when layers are put in for protection, inevitably some holes will be created. When the holes line up, things can go horribly wrong. People in the nuclear industry, the aircraft industry, the chemical and oil and gas industry, all understand this. People involved in construction (and high-rise buildings in particular) have to think more about layers of protection.

Looking forward

How did we get to this point? How did we get to a system that is clearly broken? In my view, some of this occurred because we did not take a systems view. In talking to all of the stakeholders, it became clear that most of them knew the system was not working. Actually, they would each know why a particular area was not working. Now, for the first time, we have put all of it together. We have examined how a combination of flaws in a system leads to something that cannot deliver the right outcome.

In addition to helping this sector function more effectively, I hope that the final report may stimulate examinations of other regulatory systems through a similar lens. Perhaps we can apply the same sort of thinking to these other frameworks that, too, may not be working as well as they could or should.

Over the coming months, having done the easy part of agreeing what is wrong, the challenge will be to put together a new and much more effective regulatory framework for high-rise and complex buildings. At the heart of this will be a different culture, with a shift in risk ownership and responsibility to a true outcomes-based system with responsibilities vested with the right people. □

How did we get to this point? How did we get to a system that is clearly broken? Some of this occurred because we did not take a systems view.

Working together to achieve a common goal

Graham Watts

SUMMARY

- There is a national shortage of qualified fire-safety specialists
- Higher-risk buildings like Grenfell are complex and need to be recognised as such
- 'Life safety managers' should be appointed and be responsible for all aspects of safety through the whole lifecycle of a building
- The scope of fire-risk assessments (FRAs) should be extended
- Collaboration between all interested parties is essential in order to produce the most effective response to the Grenfell disaster.

The Construction Industry Council has 50 member organisations representing professionals across the built environment. They provide expertise over the whole lifecycle of the buildings, from client requirements, through planning, design, engineering and much more, to management in use and demolition engineering. Membership ranges from large bodies like the Institution of Civil Engineers, the Chartered Institute of Building, the RICS, etc, through major research and standards-based organisations (BRE, BSI and the British Board of Agrément) all the way down to very small niche organisations, such as the Institute of Clerks of Works and the British Institute of Interior Design.

One might assume that a body like the British Institute of Interior Design would have little to add to post-Grenfell activities, but they are carrying out work into the combustibility of furniture and into the risk of death from the toxicity of burning furniture.

CIC met within a fortnight of the 14 June tragedy, with a further meeting solely devoted to Grenfell 10 days later. Every member of CIC attended and all agreed that the disaster was an outcome of a broken system.

Industry Response Group

The IRG was set up in July. It meets weekly and brings together Government, industry (specifically through CIC, Build UK and the Construc-

tion Products Association) as well as representatives of the building owners (the Local Government Association and the National Housing Federation for example). It is closely linked to the Independent Expert Advisory Panel.

Its main activity is to update information on the number of high-rise residential buildings at risk and the industry's capacity to advise upon, remove and replace cladding that failed large-scale testing. These figures have been changing week by week as new market intelligence comes in.

Some pinch points immediately became obvious, such as the lack of fire safety consultants and fire-risk assessors with experience of high-rise buildings. There are not sufficient Clerks of Works either. Much of the IRG's time has been taken up in helping owners and managers of high-rise residential towers at risk decide what to do. We have developed a decision tree and guidance on how they might deal with their 'at risk' cladding.

We are also concerned to improve efficiency; this work is focussed on quick solutions to immediate problems. It is very different from the work of the Review team, but in terms of immediacy it is no less important.

Although we made a very detailed submission to the Hackitt review, towards the end of 2017 our focus was mainly on the public inquiry. We created an expert panel from across the professions. We brought in additional experts from the Fire Safety Sector. A series of workshops led to six 'chapter groups' because they would be responsible for chapters of the submission to the public inquiry.

Critical issues

The critical issues raised through the process included:

- problems associated with lowest-cost procurement;
- improving competencies and training;
- discontinuities in the process, specifically the divisions between design and construction;

Some pinch points immediately became obvious: the lack of fire safety consultants and fire-risk assessors with experience of high-rise buildings.



Graham Watts OBE has been Chief Executive and Secretary of the Construction Industry Council (CIC) since October 1991. Prior to joining CIC, he was Chief Executive of the British Institute of Architectural Technologists from 1983. He has been Secretary of the All-Party Parliamentary Group for Excellence in the Built Environment since 2010. He was awarded an OBE for services to construction in 2008.

Action in response to the Grenfell disaster needs to be joined up with all the relevant bodies collaborating.



- product substitution, resulting in compromised performance;
- the need for clear and unambiguous roles and accountabilities.

Another set of concerns includes a need for appropriate inspections, for facilities to be signed off as safe before occupation and for improved fire-risk assessments. A better means must also be created for residents and tenants to be heard.

The CIC has also made some recommendations to the review. We think the term ‘higher risk’ – rather than simply ‘high risk’ – is a more accurate description of the type of buildings under investigation reflecting their complexity (and after all, who would want to live in a ‘high risk’ building?). What that term actually means still needs to be defined.

‘Life safety manager’

Another new concept we proposed is the ‘life safety manager’: this would be clearly understood by tenants and residents and cover the holistic needs of safety, i.e. more than just fire safety. The associated responsibilities and accountability would be handed like a baton across the successive phases of design, construction and operation. This could be achieved in any number of ways; for example, by combining responsibilities with those in the Construction (Design and Management) Regulations,

or by mirroring the system used in the Republic of Ireland where the developer/client/owner has overall responsibility and assigns it to approved contractors or approved certifiers.

Other recommendations concern fire risk assessments (FRAs). The CIC believes there should be a higher degree of competence and accreditation for assessors of higher risk buildings. The scope of fire risk assessments should be extended beyond just means of escape and they should also cover individual dwellings, not just the common parts of a structure. Colour coding certain fire-rated products would make their performance more easily recognised.

A combined and independent voice for residents and tenants is urgently needed. In addition, those in the construction site supply chain should have a means to whistle blow if they have concerns that safety procedures and regulations are being flouted.

Collaboration

It is important to stress that all of this activity following the Grenfell disaster needs to be joined up with all the relevant bodies collaborating. There is no point in doing different things in different places.

The investigations have to involve the fire safety sector, the built environment professions and the wider construction industry. They have to include all those who represent the residents and the tenants of the many, many buildings that have the same configuration of cladding and external wall insulation that was used at Grenfell. Without that collaboration we will not succeed. □

The scope of fire risk assessments should be extended beyond just means of escape and they should also cover individual dwellings.

Building a safer future

Peter Baker

SUMMARY

- Responsibility for managing risk rests with its creator and no-one else
- Regulators have a significant role in ensuring effective management of risk
- Regulation of the construction industry applies a flexible goal-setting framework with proportionality at its heart
- Health and safety has to be a golden thread running through the whole project lifecycle
- The client is also a key player in ensuring occupational health and safety in construction.

I am responsible for regulating the Construction (Design and Management) Regulations across the construction industry in Great Britain but for the seven years before that I led HSE's regulation of the onshore chemicals industry as the COMAH Competent Authority along with environment agency partners. I therefore have personal experience of permissioning regimes in major hazards as well as the lifecycle approach that we have adapted in construction through CDM.

Today's approach to high hazard industries, with their potential for high consequence, low probability events, has its roots in the Robens Report of 1972. Robens ultimately led to the Health and Safety at Work Act in 1974. The principle enshrined there, which runs through all health and safety regulations, is that 'if you create the risk, it is your responsibility for managing and controlling it'. It is duty holder's responsibility, not the regulator's or anybody else's.

The 1974 Act established the idea of continuous improvement because, of course, with innovation and change, the bar gets gradually higher over time – and rightly so.

Our approach to major hazards in Great Britain started with the Flixborough fire and explosion in 1974. Some 28 people were killed and 36 seriously injured (it might have been even worse if the incident had not occurred at a weekend).

The Advisory Committee on Major Hazards examined the way in which major hazards were being managed and controlled. The system at the time was very prescriptive and rule-based which the committee recognised was not appropriate for these situations. It noted that the infrequency of

major hazard incidents tended to breed complacency in organisations, and that a focus on rule-based approaches not only stifled innovation, it also made the regulators' job extremely difficult.

Disasters both here and abroad led to the Seveso Directives being implemented in the UK through the Control of Major Accident Hazards (COMAH) regulations. These place responsibility very clearly on the operator, both to prevent major accidents and mitigate the impact on people and the environment. Where delivery is contracted out through the supply chain, there is even greater need for coherent leadership by the COMAH operator who remains ultimately responsible and accountable for preventing major accidents.

The COMAH regime covers the full lifecycle of a facility, from concept, design and commissioning, through operation and change management, to decommissioning at the end.

Regulating major hazards

COMAH regulators have a significant – and intrusive – role in this environment. At the key stages of the lifecycle, they have to make judgements about the safety management systems and risk controls that the operators have in place.

Where a regulator identifies serious deficiencies, it must intervene. That does not mean the regulator then owns the risk – the judgements are based on information provided by the duty holder (and also site verification) which provides a snapshot of conditions on site. The ongoing lifecycle management of the risk remains the responsibility of the COMAH operator.

Our experience of applying major hazard regimes in the UK shows that a significant amount of investment is required from both the operator and the regulator in delivering the regime – and in providing independent assurance to the public. As a result, regulators routinely recover the costs incurred in their role.

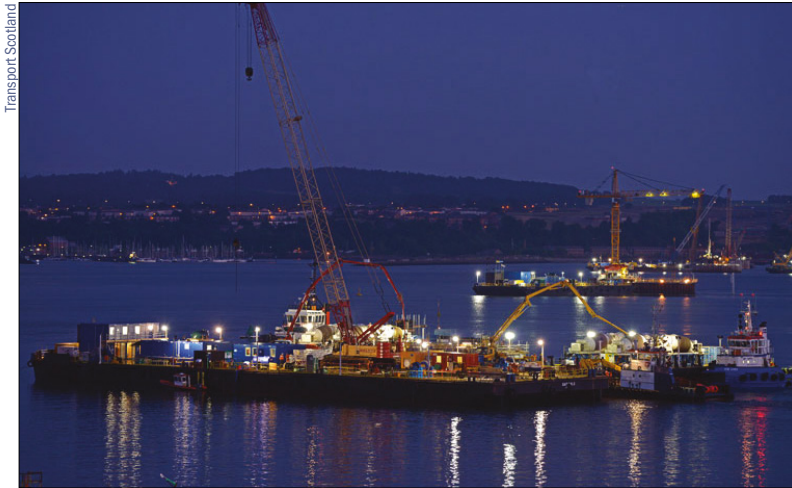
It also takes time for the concepts, the leadership, the level of culture and behaviour, to become ingrained – decades in some cases. Applying a safety case regime is a long-term venture.

Initially, safety cases and reports were often seen as either a distraction (something that the regulator wanted) or just a bureaucratic hurdle to overcome. But that was missing the point. The safety case or report is intended as a living document, a visible manifestation of the management system to help



Peter Baker has been Director of Construction Division and Chief Inspector of Construction at the Health and Safety Executive (HSE) since April 2015. He leads HSE's construction operations across Great Britain. He also chairs the multi-stakeholder Construction Industry Advisory Committee (CONIAC) and is a member of HSE's Extended Management Board. Previously, Peter was head of HSE's Chemical Industries Division, responsible for regulating the chemical and downstream oil industries.

Initially, safety cases and reports were often seen as either a distraction (something that the regulator wanted) or a hurdle to surmount.



Concrete pour by night at the Forth Replacement Crossing – construction involves a complex web of players with a broad range of activities and risk

with the management and control of risk. So, it needs to be continually reviewed and updated.

Major incidents have also demonstrated that strong leadership within an organisation (and across an industry) is crucial to ensuring that permissioning regimes operate effectively. Where that exists and is effective, businesses have a very good understanding of their key process vulnerabilities as well as the safeguards needed to prevent major accidents. The major hazard industries also need to be good at learning and sharing. That is vital because experience shows that major accidents rarely occur in novel ways, they often have similar causes to earlier events.

One of the advantages of an onshore major hazard site is that it has a fixed location. It is there for the long-term. It usually has structured management systems and short supply chains and it is very clear who is responsible for the risks.

Construction is largely at the other end of the spectrum. There is a complex web of players involved in a broad range of activities and risk – everything from domestic buildings to the Forth Road Crossing and HS2. The Construction (Design and Management) Regulations – or CDM – is the management framework applied to all of these projects, from small scale refurbishment all the way up to major infrastructure. CDM applies a flexible goal-setting framework with proportionality at its heart. At the same time, it recognises that construction involves more than just the site: there has to be a focus on the whole project lifecycle and the identification and management of risks at the earliest possible stage.

CDM integrates workplace health and safety into project management. Health and safety has to be a golden thread running through the whole project lifecycle – rather than an afterthought, bolt-on or something the contractor does – with all the key players maintaining good communications and cooperation. The regime sets clear roles and responsibilities for those who create the risks: cli-

ents, designers, and contractors. As a consequence, it encourages collaboration throughout, designing risks out at the start and identifying particular hazards from the construction phase early on. It targets effort where it can have the greatest effect, but without creating unnecessary bureaucracy.

While the principal contractor has the key role for the construction phase, the relationship between designer and contractor needs to continue as inevitably changes will be needed throughout the construction process.

The client is also a key player in ensuring workplace health and safety in construction. We know from the Olympics and other infrastructure projects that the client's approach in the early stages is critical for setting the right tone and expectations and influencing what happens subsequently. At the Olympics, the client established performance measurement and used this to influence contract delivery. Worker involvement, too, is crucial.

However, while the construction industry has general been successful in reducing safety risks since 2000-01, it recognises it needs to do more on occupational health. The Olympics and other infrastructure projects offer a model of what can be done in driving the concept of treating health like safety.

Principal designers have found CDM challenging. Previously, the designer's role could be delegated to others under the earlier legal framework. Not any longer: the design community has had to adjust to the new CDM 2015 regulations, and we want them to move quickly to the stage where designers naturally lead design, actively seek to take on the Principal Designer role, and have the in-house capability and the confidence to do so.

Competence is an important aspect of CDM and this is all about having the right people for the job. At an individual level, it involves having the right skills, knowledge, training and experience. All the organisations involved in a project, be it the client, the contractor or the designer, also need to be competent and have the organisational capability to discharge their roles, have the right policies, structures and systems, and have an intelligent approach to supply chain selection. While prequalification can be beneficial, it can also give a false sense of security to the supply chain if relied on solely and if not carried out correctly.

The construction industry has generally responded well to workplace health and safety challenges. Fatalities and major injuries have reduced over the past 18 years and the industry is making headway with the health agenda. It is through continued collaboration across all relevant stakeholders and learning from previous experiences and from each other that the industry can secure a successful future. □

Fatalities and major injuries have reduced over the past 15 years and the industry is making headway with the health agenda.

Providing practical help and advice

I, with the Chair of the National Fire Chiefs Council Roy Wilsher, Sir Ken Knight and the President of the Royal Institution of Chartered Surveyors Amanda Clack, was called into Whitehall within days of the fire and asked to join the Government's Expert Panel¹.

Our brief was not the rehousing of people impacted by the fire, nor the criminal investigation or public inquiry, nor the Building Regulations Review (subsequently conducted by Dame Judith Hackitt), but instead to focus on any immediate broader implications from the tragic fire for public safety of people in high rise residential towers. And to provide advice a guidance on what steps to take.

The priority for all our work has been the people in these buildings, keeping them safe and helping that they feel safe.

When we saw what had happened, the first thought was "Surely that was a rogue building? Surely nobody would wrap a building in something that is so clearly combustible, where fire can spread so quickly?" But then the thought occurs: "Or perhaps it could happen?"

First advice

Our first advice to the Secretary of State was to say "We have to determine whether or not there are any other buildings in a similar state."

An instruction was sent to all building owners that might have aluminium composite panelling on high rise blocks – direct to local authorities and housing associations for the social housing sector and to public bodies like schools and hospitals, as well as through umbrella bodies for private sector landlords – to send samples in and get them screened.

We expected the results would show that most were all right: in fact, though, most were not!

Roy deployed fire service people around the country and within 24 hours of screening, buildings were being inspected. In many, fire wardens and other measures were put in place.

The challenge for the Expert Panel was this: with an increasing number of buildings known to be surrounded in combustible materials, can such systems ever be safe? Because cladding is a system – there is a rain screen on the outside, a gap, fixings and insulation, and then behind that there are different sorts of wall type and window details.

The building owners were asking what they

should do? We carried out some system tests and found there was no combination using that combustible core, rain screen and aluminium composite material which was safe. We immediately published advice that people should consider removing these materials, but in a safe way.

Of course, every building is different – it has been maintained differently, it has different insulation characteristics, it is a different design. Competent professionals were needed to inspect buildings, determine whether a particular building was safe and decide what actions needed to be taken.

As this is a national problem, we realised we needed to draw on the industry. So the Industry Response Group was formed with the Construction Industry Council, the Construction Products Association and the Contractors Group working with the supply chain to help building owners and operators.

The Expert Panel's work is published online and is focussed on practical advice to help people decide what to do. We have the Industry Response Group, the Hackitt review and the public inquiry, all of which we hope will synergise change, progress and action. □

¹ www.gov.uk/government/collections/building-safety-independent-expert-advisory-panel



After the formal presentations, Dr Peter Bonfield OBE FEng, Chief Executive of the BRE Group, described his experience as a member of the Independent Expert Advisory Panel.



Within 24 hours of screening, buildings were being inspected.

The debate

Following the speakers, participants debated extending responsibility for safety across the whole lifecycle, culture change, rule-based and risk-based approaches, the experience of other countries, and competence.

It is difficult to keep large multi-occupancy buildings safe when they have a substantial number of separate leaseholders in residence – and even more so if many of the units are occupied on a very short-term basis. Each building may need an individual system of fire safety assurance, taking account of the changes which individual leaseholders might make to their own parts, for example through installing broadband or individual heating systems.

Greater safety may involve legislation and stronger enforcement of the maintenance of fire doors as well as a requirement for mandatory gas appliance servicing. Renovation of buildings can introduce greater risks. Full records of building changes must be maintained and risk assessments made before the changes are applied. Alterations made during construction, which introduce differences from the plans originally approved, also need to be logged properly.

The progress made in reducing construction deaths and injuries has shown that cultural change is possible. Those involved in the design and construction of buildings should have some responsibility for the safety of those buildings in use. Better training of residents in how to respond to a fire would help, and indeed has been shown to work. Some 20 years ago the Fire Service ran significant community engagement programmes on smoke detectors and furniture flammability. A return to programmes like this could be beneficial.

In the rail sector, a switch from rule-based to risk-based safety regulation has proved effective. In considering how to introduce effective action when systemic errors are identified, practice in other areas as diverse as medicine, aviation and shipping may provide some case studies, as well as the high-hazard sectors of chemicals, nuclear and rail.

Regulatory experience abroad should be considered as well as that in the UK. The faster pace of construction in France has been examined in a review led by Sir Oliver Letwin MP. There is bound to be further debate about the scope for safer evacuation of people from tall structures. The provision of multiple staircases may be an essential component. Despite the recent tragedy, substantial progress has been made in fire safety over the past 20 years, with around 1,000 annual deaths then and around 250 more recently.

Competence for those with key responsibilities involves much more than just qualifications. Experience has to relate to the specific risks. Achieving culture change is essentially a process involving people. In the social housing sector a re-introduction of caretakers in some estates has done much, at relatively low cost, to transform relationships and build better practice, for example in terms of keeping fire doors closed and keeping exits clear. □

FURTHER INFORMATION

The Hackitt Review – final report

www.gov.uk/government/publications/independent-review-of-building-regulations-and-fire-safety-final-report

The Hackitt Review – interim report

www.gov.uk/government/publications/independent-review-of-building-regulations-and-fire-safety-interim-report

Grenfell Tower Inquiry – www.grenfelltowerinquiry.org.uk

Independent Expert Advisory Panel

www.gov.uk/government/collections/building-safety-independent-expert-advisory-panel

Building Research Establishment – www.bre.co.uk

Chartered Institute of Building – www.ciob.org

Construction Industry Council (CIC) – www.cic.org.uk

Construction Products Association (CPA) – www.constructionproducts.org.uk

Institution of Fire Engineers – www.ife.org.uk

Local Authority Building Control in England and Wales (LABC)

www.labc.co.uk

Ministry of Housing, Communities and Local Government

www.gov.uk/government/organisations/ministry-of-housing-communities-and-local-government

National Federation of Tenant Management Organisations (NFTMO)

www.nftmo.com

National Fire Chiefs Council – www.nationalfirechiefs.org.uk

The Hackitt review's final report

The interim report identified that the current system of building regulations and fire safety was not fit for purpose and that a culture change was required to support the delivery of buildings that are safe, both now and in the future. The system failure identified in the interim report has allowed a culture of indifference to perpetuate, specifically:

- the roles and responsibilities of those procuring, designing, constructing and maintaining buildings are unclear;
- the package of regulations and guidance (in the form of Approved Documents) can be ambiguous and inconsistent;
- the processes that drive compliance with building safety requirements are weak and complex with poor record keeping and change control in too many cases;
- competence across the system is patchy;
- the product testing, labelling and marketing regime is opaque and insufficient;
- the voices of residents often go unheard, even when safety issues are identified.

In her foreword to the final report, Dame Judith notes that these issues “have helped to create a cultural issue across the sector, which can be described as a ‘race to the bottom’ caused either through ignorance, indifference, or because the system does not facilitate good practice. There is insufficient focus on delivering the best quality building possible, in order to ensure that residents are safe, and feel safe.”

New framework

The new regulatory framework called for and described in the final report must, says the text, address all of these weaknesses if there is to be a stronger focus on creating and maintaining safe buildings. It must strengthen regulatory oversight to create both positive incentives to comply with building safety requirements and to effectively deter non-compliance. It must clarify roles and responsibilities. It must raise and assure competence levels, as well as improving the quality and performance of construction products. Residents must feel safe and be safe, and must be listened to when concerns about building safety are raised.

The report argues that this new regulatory framework must be delivered as a package. The framework will be based around a series of inter-dependent, mutually reinforcing changes where one new measure drives another. In doing so it

will reflect the reality of most high-rise buildings which operate as a complex inter-locking system. Only this genuine system transformation will ensure that people living in high rise buildings are safe and have confidence in the safety of their building, both now and in the future.

The new framework is designed to:

- create a more simple and effective mechanism for driving building safety;
- provide stronger oversight of dutyholders with incentives for the right behaviours, and effective sanctions for poor performance;
- reassert the role of residents.

In making these changes, the new framework will also radically enhance the current model of responsibility so that:

- those who procure, design, create and maintain buildings are responsible for ensuring that those buildings are safe for those who live and work in them;
- Government will set clear outcome-based requirements for the building safety standards which must be achieved;
- the regulator will hold dutyholders to account, ensure that the standards are met and take action against those who fail to meet the requirements;
- residents will actively participate in the ongoing safety of the building and must be recognised by others as having a voice.

The final report acknowledges that the implementation of the package proposed may take some time. While some of the recommendations can be delivered in the short term, some will require primary legislation. In the meantime, industry must start ‘living’ the cultural shift that is required – the most important element of achieving that will be leadership from within industry.

It is therefore important that Government develops a joined-up implementation plan to provide a coherent approach to delivering the recommendations in this report. □

www.gov.uk/government/publications/independent-review-of-building-regulations-and-fire-safety-final-report

Industry must start ‘living’ the cultural shift that is required – the most important element of achieving that will be leadership from the industry.

The review's final report, which was commissioned by government following the Grenfell Tower fire to make recommendations on the future regulatory system, was published on 17 May 2018.

THE FUTURE OF FARMING

How can farming in the UK meet the demand for food production while at the same time delivering environmental benefits? The challenge was debated at a meeting of the Foundation held at the Royal Society on 21 March 2018.

Re-imagining our farming system

Ian Boyd



Professor Ian Boyd FRSB FRSE is Chief Scientific Adviser at the Department for Environment, Food and Rural Affairs (Defra). He was previously Director of the Scottish Oceans Institute at the University of St Andrews and the Sea Mammal Research Unit. He is a marine and polar scientist and a professor at the University of St Andrews.

The agricultural sector faces four key types of challenge: environmental, productivity-related, social and strategic. The last of these cuts across all areas of farming. It encompasses Defra's recent consultation on the future for food and farming, the 25-year Environment Plan, the Industrial Strategy, the Clean Growth Strategy and the forthcoming Resource Efficiency and Waste Strategy.

Environmental challenges

The objectives of the 25-year Environment Plan are clean air and water, thriving wildlife, reduced drought and flooding, efficient use of natural resources and enhanced cultural heritage. The plan aims to optimise the stock and flow of natural capital. Farming has eaten into many of our natural assets. For example, farmland bird species have declined by 54% since 1970 (Figure 1).

There are a number of ways in which the country might meet its environmental challenges. Land could be released for other functions such as carbon sequestration and biodiversity recovery. The efficiency of food production could also be improved: farming is currently less than 10% efficient in terms of calories, and 25% of produce is wasted. In addition, the use of nitrates and pesticides creates environmental problems.

To solve these problems we need to re-imagine how we produce our food. The sector has to embrace new technologies and aim for minimum-waste, minimum-emissions farming. Solving the environmental challenges will also address some of the productivity challenges.

Productivity challenges

Overall economic productivity levels in farming have not changed significantly during the past 10 years. There have been some slight increases in specific areas, but these reflect decreases in input. More worryingly, total outputs have not changed since 1983: in other words, there have

SUMMARY

- Farming faces challenges in four key areas: environmental, productivity-related, social and strategic
- The country needs to improve the efficiency of food production and aim for minimum-waste, minimum-emissions farming
- Farming productivity is susceptible to volatility caused by market forces, exchange rates and other external shocks
- Farm profitability varies widely by sector
- Measures of success should reflect policy objectives and reward outcomes.

been no meaningful increases in production for about 40 years. Clearly, productivity is an issue that needs to be addressed.

Farming productivity is subject to volatility. Some of this is caused by exchange rates – farm incomes tend to follow the Euro exchange rate. A weak pound means higher farming income, whereas a strong pound reduces farming income. Other factors contributing to volatility are changes in direct payments, changes in production and external shocks. The poor farmer has to manage in the face of all these factors. Addressing some of the environmental challenges might also help to smooth out the issues causing volatility.

Social challenges

Large numbers of farmers lose money from farming (Figure 2). While there are successful farmers, 50% get their money from sources other than farming, including direct payments, diversification, and agri-environment activities.

There are 9.1 million hectares of farmed land. Some 8% of the land belongs to small farms, which represent 42% of all farms but produce 2% of total farming output. At the other end of the scale, 55%

of total output is produced by large farms, which represent 7% of the total number and have 30% of the farmland. In simple terms, this boils down to the 80/20 rule: 20% of farmers produce 80% of the production on roughly 50% of the land. These figures show clearly that there are a very small number of highly productive farms, and a much larger number of relatively unproductive ones.

Profitability also varies by sector. Overall, mixed grazing, livestock and cereal farms make a loss from agriculture. There are some real contrasts here, though. Poultry farming is the most profitable, followed by pig and dairy farming. This correlates with the level of subsidies, or direct payments, which account for 79% of income in cereal farming compared with 8% in poultry farming. Cereal, grazing and mixed farms drew 75% of farm business income from direct payments. The north east has the highest reliance on subsidy – 98% of farmers rely for their businesses on direct payments in this region, whereas in East Anglia, for example, it is 47% – a much lower number.

The most successful sectors of agriculture have the highest employment rates. However, the largest number of people are involved in the lowest performing sectors because these have a very large number of relatively small businesses.

Fewer than 50% of farms in the UK use normal business management systems with a cash flow and business plan. In the lowest performing sectors – grazing livestock and mixed farming – fewer than 20% run a cash flow and a business plan. Some quite basic measures would help the farming sector raise its game, and simply having better business systems in place would help a great deal. There is a strong debate about whether the current situation has been driven by the Government's withdrawal of extension services to farmers.

Strategic challenges

England is the largest contributor to the UK's agricultural production, accounting for 76%, followed by Scotland at 14%, and Northern Ireland and Wales at 5% and 4% respectively. This is to be expected since England has the most farmland and the best soil. However, agriculture's contribution to overall GDP is relatively small. Indeed, it has declined over a very long period of time and has flattened out at 0.5%. We need to find ways to grow this proportion in the future.

The UK imports 50% of its food. This needs to be borne in mind when making decisions about the environment. Policies that would hamstring farmers and make them uncompetitive in the world market must be avoided.

It is clear that the EU's Common Agricultural Policy (CAP) has not been entirely successful. It

The environmental challenge

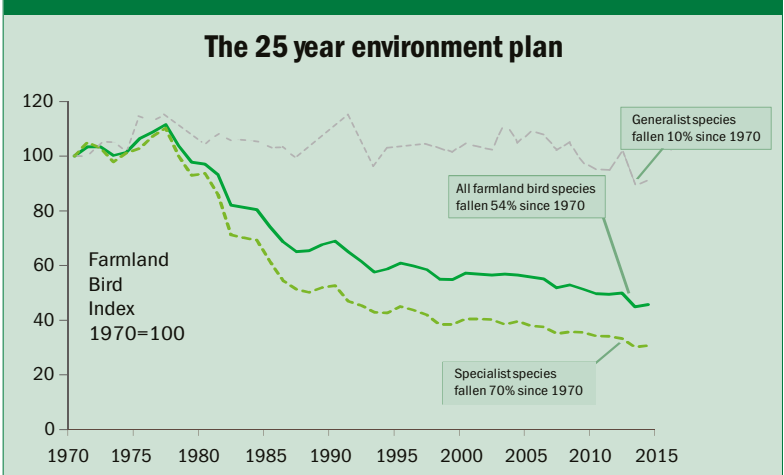


Figure 1. Changes in bird populations since 1970

The social challenge

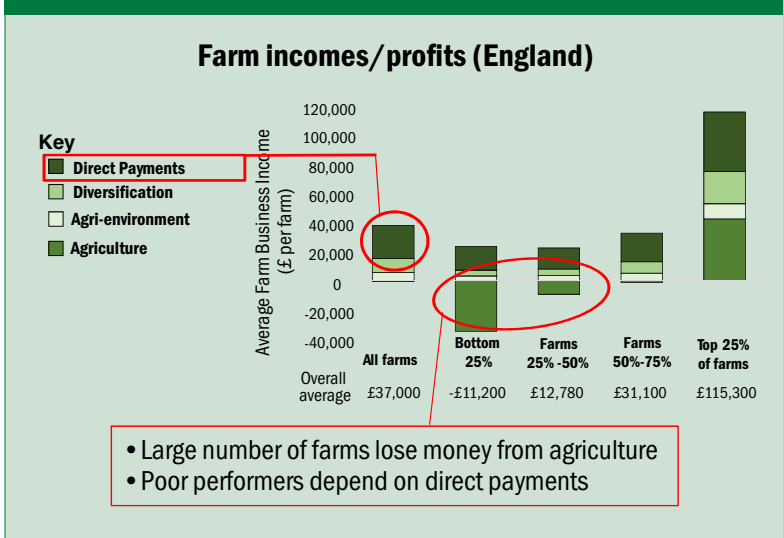


Figure 2. Farm incomes in England

has focused on social outcomes, where it has done very well, but to the detriment of environmental and productivity outcomes.

The UK needs a clear and balanced set of objectives that are consistent across all scales, so that if farmers are being paid for particular outcomes at a field scale, this also works at a national scale in terms of national outcomes.

Some hard choices will need to be made. There will no doubt be winners and losers, and the losers should be compensated appropriately.

Any new system needs to be sensitive to particular farming sectors – there are wide variations across different types of farming. It also needs to be sensitive to geography, because farming depends on the soils and the climates. The CAP lacks this level of sensitivity. Measures of success need to be chosen that reflect policy objectives and that reward outcomes.

A vision for agriculture

Minette Batters



Minette Batters is President of the National Farmers' Union (NFU). She runs a tenanted family farm in Wiltshire. She co-founded the campaigning initiatives 'Ladies in Beef' and 'Great British Beef Week'. She has been an NFU member from grassroots through to County Chairman and served as Wiltshire's Council delegate and also as Regional Board Chairman for the South West. Minette has also been a member of NFU Governance Board and served as NFU Deputy President from 2014 to 2018.

Farming is the bedrock of the food and drink industry, the UK's largest manufacturing sector. Farming provides employment for 3.9 million people and contributes £112 billion to the UK economy. Over the past 20 years, farmers have planted 30,000 kilometres of hedgerows and created 27,000 kilometres of grass margins.

Modern farming aims to be sustainable, profitable and progressive. One third of farmers have already diversified into renewable energy. We have reduced our use of nitrogen fertiliser by 31%, and phosphate use has been reduced by 55%. In addition, we have cut pesticide use by half over the past 20 years and reduced our greenhouse gas emissions by 17%.

At the same time, farmers and growers need to be able to hit every price point. They need to add value where they can. However, we are still experiencing widespread austerity, with many people struggling to make ends meet. Hitting every price point means hitting different price points for different incomes. We want to provide good quality, affordable, traceable food for everyone in the country.

The Government set out its case for change in its consultation paper *Health and harmony – the future for food, farming and the environment in a Green Brexit*. In response, the NFU has set seven key tests for any future agricultural policy:

- ambitious;
- comprehensive;
- promotes competitiveness and financial resilience;
- reduces administrative burden;
- maintains a level playing field;
- provides fair reward for environmental goods;
- provides a deliverable and certain transition.

The NFU wants to see a policy that is fair to all active farm businesses irrespective of size or system; one that provides sufficient time and certainty for active farm businesses to plan, with opportunities for them to adapt and invest. It seeks a policy that results in a more profitable, progressive and sustainable farm sector that is respected by

SUMMARY

- The NFU has set key tests for future agricultural policy aimed at ensuring profitable, progressive and sustainable farming
- Farming needs to use science and technology, and embrace digital solutions, to achieve its aims
- Labour requirements must be met through a global, seasonal agricultural work permit scheme
- Internationally, the UK is a highly-prized target market
- Farmers need to hit every price point to compete, but also need a policy that is fair to all farming sectors.

society for its high standards of food production, environmental care and animal welfare. Finally, we would like a policy that harnesses all parts of the Government and the food chain to deliver a successful and thriving farming sector.

To achieve its aims, farming needs to use science and technology. Science provides the evidence base that enables us to achieve and measure our successes. We need an agricultural revolution that is driven by traceability and the opportunity to be able to show what we are doing: if we want to be world-class we need to have an evidence base that is available at the click of a button.

For example, we have data showing that we have more than met the target set by Defra in 2016 of using no more than 50 milligrams of antibiotics per kilogram of meat produced. However, we are still largely reliant on paper-based systems and on printing off spreadsheets to demonstrate this and other standards we are achieving. Farmers need to embrace the digital age, and this requires good internet connections.

The NFU's horticultural board has one pressing issue and that is the labour requirements for this and coming years. I recognise that it is a Government ambition to be the first developed nation to become fully mechanised and fully automated, and it is true that we have the capability to pick a strawberry or cut a flower with a machine. Yet achieving the target involves significant timescales and depends on investment.

Today, we need a global seasonal agriculture work permit scheme. Currently we need 80,000 people to pick and pack our fruit, vegetables and

Science provides the evidence base that enables us to achieve and measure our successes. We need an agricultural revolution driven by traceability.

flowers. That does not even begin to address the question of the permanent workforce.

Everyone understands how important the European market is to the UK. Recently we have been in discussion with people from New Zealand, Australia and Canada. The UK is seen globally as a prized market. Argentina has quadrupled its global food exports. The Canadians spent 10 years negotiating their Comprehensive Economic and Trade Agreement (CETA) with the EU, and this was largely because they wanted access to the UK market. This is important for our farmers. We need to be the country's first supplier of choice by hitting every price point, competing effectively with these other countries and ensuring that people buy British not only out of loyalty, but because it is the best produce.

As well as being the most prized market, the UK is also the most challenged market in the world. It has a unique retailer environment. We live with an

We need a global seasonal agriculture work permit scheme. Currently we need 80,000 people to pick and pack our fruit, vegetables and flowers.

ongoing price war as well as factors such as the national living wage and rising business rates. Every farmer I speak to would far rather farm without support if they could get a fair return in the marketplace. We need to ensure fairness, even if this means challenging the supply chain and potentially challenging competition laws.

Different sectors of farming have different needs and are going into Brexit from different starting points. Cereals, dairy and livestock rely more heavily on subsidies than poultry or pig farming. That means different solutions for different sectors. At the same time, within the NFU, we have to challenge our farmer members to be more ambitious and innovative. □

Taking an organic and integrated approach to farming

Helen Browning

SUMMARY

- Integrated solutions are needed to protect the environment and meet food requirements
- Organic farming provides both environmental benefits and good-quality food
- Agroforestry has recently been recognised as a way of benefiting the environment and enabling a larger variety of food to be produced
- 'Re-wilding' may be another cost-effective way of protecting the environment, with some food production too.
- Future policy needs to take into account geographical differences in land productivity.

I have always been very keen on finding integrated solutions to secure environmental benefit from farming while meeting food requirements. I was drawn to organic farming because it seemed a very elegant solution to a number of the challenges that were already clear 30 years ago. The biodiversity crash was happening even then. Soils were starting to run out of steam. There were issues around animal welfare,

particularly in the intensive pig and poultry farming of the time. Energy efficiency was as bad or worse then as it is now. I saw organic farming as a way of trying to combine the environmental benefits that I really cared about with the commercial opportunity to conduct business and produce good quality food.

What is the most urgent problem we need to crack now? Is it climate change, the biodiversity crash or the health crisis, much of which is diet-related? In fact, there is an urgent need to take a systematic approach to tackle all of these, rather than looking at each issue in isolation.

Agroforestry

Agroforestry is one of the new solutions that are entering the frame and ought to be taken more seriously as part of our future farming policy. Agroforestry brings trees into the farmed environment. I will be planting trees on 200 acres of land over the next three or four years and the benefits of that will be substantial. It will increase the total yield of that land by as much as 50% and enable production of a much greater variety of products, including timber, biomass, nuts and fruits. The benefits to biodiversity are huge.



Helen Browning is Chief Executive of the Soil Association. She has a mixed organic farm in Wiltshire, with dairy, beef, pigs, and cereals, and is now also experimenting with agroforestry. She is a member of the Food Ethics Council, trustee of the RSPB Wildlife Charity and was recently appointed to the Food, Farming and Countryside Commission. She was previously Director of External Affairs for the National Trust and has had a number of roles in agri-politics.

Harvesting wheat in a mixed timber system – agroforestry is an effective technique for marrying productive farming with benefits for the environment.



Agroforestry also stabilises the soil, helps to prevent flooding and is good for livestock. It is a good example of a new solution (in this country; agroforestry is a well-established technique in many other countries) for marrying productive farming with benefits for the environment.

Disruptive technologies that utilise insects, algae, fungi or systems such as vertical farming and aquaponics to produce food also have potential to reduce pressure on the land.

Re-wilding

It will be interesting to see whether future policy allows some regeneration of real nature or 're-wilding'. It need not all be planted forest. I am fascinated by how much food can be produced from a semi-wild system; it can be very cost-effective. I am reminded of the lesson learned from the American dustbowl, the part of the American mid-west where the native bison were gradually destroyed and then replaced with roughly the same number of feedlot cattle. That was an example of making a lot of work for ourselves in an attempt to produce food that is still relevant today.

It is evident that some parts of the country are easier to farm and more productive than others. Similarly, some parts are more environmentally blessed. Future agricultural policy needs to be geared to these geographic differences and should work to exploit them. For example, it makes sense for the uplands to secure environmental payments for the benefits they provide to society as a whole. Some of our very heavy clay soils might be



A research and development vertical farm

better used to sequester carbon and manage water flows than be ploughed or cultivated.

Farming is currently commercially unviable in many places without support. When I started farming over 30 years ago, one of my convictions was that we would not have the Common Agricultural Policy (CAP) for much longer. I spent a lot of my life trying to build a business that would be able to survive when the CAP went. Farmers are independent by nature but can be extremely bad at putting that independence into practice. Although I have never been a supporter of direct payments, it may be that the most economically efficient place to put money is at the farm level, if cheap or affordable food is our priority. □

Although I have never been a supporter of CAP direct payments, it may be that the most economically efficient place to put money is at the farm level.

The debate

The debate after the presentations discussed topics such as incentives, specialisation, research and disruption.

At what scale should incentives be introduced in order to achieve the desired environmental, economic and social outcomes? For example, one might take action at the scale of catchment areas, where deployment of financial instruments (perhaps involving the insurance industry) could incentivise farmers and others to work together to achieve the desired range of outcomes. It will be important to ensure that local planning authorities do not work against such arrangements. However, it is hard to predict the response at farm level to new policies and incentives, so care will be needed to avoid unintended outcomes.

Agricultural land use is far from optimal in the UK – it often does not reflect latitude, climate and soil variations. More could be done to improve this, and to better inform farmers' choices.

Should the UK focus on high-quality food at a higher price, or on hitting wider UK and global price points? One way or another, the UK has to find new global markets for its farmers, and trade agreements should not put barriers, such as environmental barriers, in the way of this.

Need for research

Research relevant to agriculture, such as soil science, has suffered in the UK. Steps are being taken to reverse this, but the outcomes from new research are unlikely to have an effect for 10 to 20 years. It is important to maximise the use of new technologies to boost productivity now. Genetics is a good example of this, where the UK has already benefited in boosting poultry productivity. Perhaps now is the time to transform horticultural productivity including through genetics?

New Zealand is a country that has seen radical changes to agricultural policy. There, the focus has been on what the country is best suited to do thereby. This has enabled the country to improve productivity, but the social and environmental costs have been severe.

Food supply chains are vulnerable to disruption from a range of factors including weather, flu pandemics and many other things. Food security is a public good and Defra should be encouraged to give it high priority.

The opportunities and challenges facing UK agriculture as we leave the EU are complex and interrelated. It is essential to consider both individual factors and aggregate effects. There should

be an evidence-based approach as well as incentives to achieve desired outcomes. The details of the desired outcomes and the best means of achieving them remain open to debate. □



J Kelley / Soil Science

Research relevant to farming, such as soil science, has suffered in the UK.

FURTHER INFORMATION

Command Paper Cm9577 and Consultation Letter, Defra *Health and Harmony: the future for food, farming and the environment in a Green Brexit*
www.gov.uk/government/consultations/the-future-for-food-farming-and-the-environment

25-Year Environmental Plan, Defra
www.gov.uk/government/publications/25-year-environment-plan

Biotechnology and Biological Sciences Research Council
www.bbsrc.ukri.org

Natural Environment Research Council – www.nerc.ukri.org

Agricultural Industries Confederation – www.agindustries.org.uk

British Cattle Breeders Club – www.cattlebreeders.org.uk

National Farmers Union (NFU) – www.nfuonline.com

Royal Agricultural University – www.rau.ac.uk

The Soil Association – www.soilassociation.org

The Tenant Farmers Association – www.tfa.org.uk

DISTRIBUTED LEDGER TECHNOLOGY

Distributed ledger technology and blockchain are expected to make a significant impact on the financial services sector. But why is this technology potentially so important? A meeting of the Foundation, held at the Royal Society on 25 April 2018, looked at the issues.

The impact of distributed ledger technology

Chris Corrado



Chris Corrado was appointed Chief Operations Officer (COO) and Group Chief Information Officer (CIO) of London Stock Exchange Group in November 2015. He was previously a Managing Director at MSCI, responsible for technology, data services and programme management from 2013. Chris has more than 30 years of experience in managing technology platforms and transformational change in the financial services industry. Prior to joining MSCI, Chris held a variety of senior CTO roles in leading banks, including Morgan Stanley, Deutsche Bank, Merrill Lynch and UBS.

At London Stock Exchange Group (LSEG), development of Distributed Ledger Technology (DLT) and blockchain has both internal and external applications. Internally, the aim is to use these technologies to reduce error rates and so improve our cost structure.

Involvement was initiated through an emerging technologies group. By the end of 2015, the decision had been taken to focus on the Hyperledger Fabric. Part of the reason was that it is open source. We believed we could learn faster, as well as benefiting from collaboration with other partners like IBM. We have been working together on different use cases to evaluate what this technology could do for us and our customers. In one of our Italian companies, Monte Titoli, we have taken paper-based shares and digitised those assets on a blockchain. That has proved very successful.

One major benefit would be the elimination of reconciliation: with an authoritative source of data, there is no need to reconcile different data stores. Yet these are still early days and we have not fully explored the potential yet.

As part of LSEG's open access philosophy and customer partnership approach, we have been working on projects with a number of customers: some worked out well and some were not so successful. With any emerging technology, though, there is a degree of experimentation where the results are not guaranteed. A willingness to fail offers opportunities to learn and then to use that learning in the next project with a customer.

The needs of the customer

External customers are now asking us to interface with different types of DLT that they are using and this is requiring us to broaden our horizons beyond just the Hyperledger Fabric. With knowledge of a broader array of technologies, we will be able to interface better with clients. Businesses that are unwilling to experiment jointly with their customers will be left behind.

SUMMARY

- With authoritative data sets on a blockchain, reconciliation can be eliminated and efficiency savings made
- Reliability and scalability are two key requirements for the industry
- DLT could have a major impact on capital-raising for small and medium-sized enterprises
- There is yet no single dominant market solution
- This technology provides significant opportunities in the financial services sector.

Keeping stakeholders informed, including our regulators, is very important. It is not so much about explaining why we are doing this, more about describing what we are learning. For regulators in the financial services sector, this is a technology that addresses a real problem. Reconciliations involve either automated or manual processes that can go wrong and global regulators are interested in solving that problem.

Hyperledger offers good redundancy and resiliency with no single point of failure: that is critical. It offers a private network that meets enterprise standards, with data segregation where clients only see the data they have permission to see, as well as a flexible consensus model – all these are important. In addition, companies like Intel, IBM and the Linux Foundation are supporting this technology.

The greater the dependency on this type of technology, though, the more that resilience matters. Some years ago I worked at IBM modifying the operating systems on big mainframe computers. From there I moved to Morgan Stanley and the distributive computing world: instead of managing six computers the number rose to 10,000, a completely different problem. Reliability and scalability matter just as much, but the situation is much more complex to manage.

The challenge was to manage multiple vendors in a very large-scale environment in a way that was as reliable as the mainframe computers. In the end, that involved building a great deal of proprietary software interfacing with Unix-based open systems. There was an awareness that it might break down at some point, but it was not possible to predict precisely when. So the focus was on anticipating problems and when something did happen, it was vital to ensure that there was little or no impact on the operating environment. More and more, that will be the approach needed with DLT implementations. It is not just about throughput, but also the reliability of the underlying infrastructure.

The industry in which we operate consists of members that trade together, that are dependent on each other and that are involved collectively in reconciliation – and there has to be an extremely high degree of confidence that the systems all work as designed. People may say that DLT creates disruption, but in reality there has to be a guarantee that the transactions are valid and have high integrity. It is essential to ensure the technology works well, and that comes down to reliability, scalability, proper instrumentation and so on.

I believe that, even for open source implementations, there will be several different variants that include proprietary technology, not just in order to add scalability and reliability but also to add further features and services.

Efficiency

I have already mentioned the potential for efficiency gains through eliminating any kind of reconciliation. This in turn reduces settlement times. This technology also allows for much more efficient and direct regulatory reporting. IT costs are reduced over time as well as operational middle-office and back-office costs. There is potential to develop a number of other applications, such as the digitisation of assets and smart contracts. Of course, the risk with this is that there are a lot of eggs in one basket, which increases the reliance on the scalability and reliability of the underlying technology.

Among the short-term opportunities under investigation are:

- the digitisation of bonds and equities for smaller, mid-market companies;
- the creation of new secondary markets beyond the traditional exchange for smaller issuers;
- a lower cost of raising capital as costs can be compressed once expensive reconciliation is eliminated;
- the digitising of commodities on a blockchain.

There has to be a guarantee that the transactions are valid and have high integrity. that comes down to reliability, scalability and proper instrumentation.

Looking to the longer term, the way that Central Securities Depositories (CSDs) and their custodians operate will change significantly. This does not necessarily change the regulatory environment, it just changes what people do to comply with regulation. As fewer systems will be involved in a settlement process, it should become simpler and faster.

LSEG is not creating its own labs and investing directly in companies. Instead, we have focussed on membership of different consortia so that we can learn and also contribute. In this way we can see what customers are interested in and what they are adopting. I believe that we will end up having a core solution within the firm which we will offer our members as part of our business model. However, we will also develop expertise and possibly a number of different solutions because of the business mix. Customers include clearing houses, information businesses (indexes and analytics specialists) and then there are the exchanges.

Lessons learned so far

The greatest initial opportunities for this technology lie in small/medium sized capital raising and bond issuance, the creation of secondary markets and standards for valuation, as well as the digitisation of commodities.

The replacement of infrastructure will take a long time. Replacing legacy infrastructure is difficult at the best of times but here it will be replaced with new technology that has to be – and be seen to be – reliable. However, it may not be prudent to bet on a single dominant player, the technology is still young and relatively undeveloped.

The benefits to us as a business are really derived from the services we will offer on the blockchain. We have to get up to speed quickly on how we build services on the various blockchains: some are easier to work with than others. The Digital Assets platform, for example, is good if you understand their language and we are learning that now. SETL has something similar – a script-type language which allows users to interface to the underlying blockchain.

The success of a business in this area is directly related to the ease of creating services on the blockchain. Learning how to do that is a big investment. In some ways it is analogous to the move in the

The success of a business in this area is directly related to the ease of creating services on the blockchain. Learning how is a big investment.

We have moved beyond ‘will it work?’ to ‘how does this help us become more productive?’.

1980s from mainframe computing to a Unix environment. Think of all the programmers that had to be hired and trained initially to do C and C++, but then ultimately Java became the standard.

London Stock Exchange Group, and the industry more generally, is making a whole series of

investments in this technology. We are becoming less focussed now on one implementation platform. We are expanding our interactions with other organisations in this rapidly developing marketplace. We see demand increasing from customers, we see new tools that can make us more productive at creating services. We have moved beyond ‘will it work?’ to ‘how does this help us become more productive?’ □

A potential for transformational change

Shirine Khoury-Haq



Shirine Khoury-Haq joined Lloyd's in July 2014 as Chief Operating Officer and her remit includes business transformation, global operations, data, information technology and corporate real estate. She is responsible for driving forward modernisation across Lloyd's and the wider London market as the sponsor of the London Market Target Operating Model (TOM) initiative. Shirine joined Lloyd's from Catlin, where she was Group Head of Operations and UK Chief Operating Officer. Prior to this, Shirine was an Associate Partner at IBM, specialising in large systems and business transformation projects as well as post-merger/acquisition integration.

Lloyd's is the world's largest insurance market – it is not a bank! It has a global reach with 57 insurance companies managing over 90 syndicates, operating in more than 200 countries and territories worldwide. In London, it operates within an ecosystem (including competitors and many brokers) of 350 firms and 52,000 people. There is an average of five firms for each of the risks we underwrite. There is a huge amount of reconciliation to be done in terms of getting all the numbers right, issuing premiums and settling claims.

From start-ups and small or medium-sized enterprises (SMEs), to national governments and multi-national corporations, our customers really are the people driving the global economy. They rely on the specialism, strength and security of the Lloyd's market to help protect what matters to them. Since our foundation, we have helped customers around the world withstand shock, recover and rebuild.

Last year, worldwide, our market paid claims totalling more than \$25 billion gross of reinsurance. We have helped the world recover after disasters like the US and Caribbean hurricanes, the Mexican earthquake, flooding in Bangladesh or the mudslide in Columbia. We have been around for 330 years and insured the first cars, the first planes, the first satellites. Lloyd's leads the world today on new risks like cyber-security. As new challenges arise, we are generally the market that insures them.

While very innovative on the product side, insurance typically does not rank very highly for its use of technology. As Chief Operating Officer of Lloyd's, I have been asked by member firms to drive the modernisation and digitisation of that market. Taking away the paper that people have

SUMMARY

- Distributed Ledger Technology has the potential to revolutionise the insurance industry
- The technology can speed up essential verification checks while reducing costs
- The risks from new technology need to be assessed and resolved
- Privacy concerns on distributed networks need to be addressed
- UK and international regulators are collaborating on a coordinated approach.

been so attached to for over 300 years is quite a challenge not only from a technology perspective, but from a cultural perspective too. Yet we have to explore ways of improving customer experience, making it easier to do business, and of course reducing our costs.

Some 30 years ago, the dotcom boom and the rush to be early adopters demonstrated the risks of investing money without understanding how that technology worked and how to exploit it in an appropriate way. The current buzz around blockchain is sometimes described in a similar way. We must be clear about what blockchain is (and what it is not) and how it can help achieve long-term strategic goals.

Distributed Ledger Technology (DLT) has the potential, we believe, to revolutionise the insurance sector. It can be applied to a number of areas including underwriting, claims management and back-office functions. It can also afford real opportunities for collaboration, resilience, security and privacy. The opportunities are not solely

about creating a shared ledger (although that in itself is of huge benefit): the new technology could enable a radical rationalisation by removing the need for each party to update data continually, with associated savings on operational costs.

Yet when you look at the value chain within our industry there is a further opportunity. Brokers, insurers and reinsurers all have to make appropriate checks and screening to ensure that they identify the parties that are involved in an insurance contract, both legal entities and individuals. This verification can be very time-consuming and expensive. DLT can speed up this process while reducing costs. It also reduces the likelihood of consumers committing identity fraud.

Looking at underwriting, collating information involves underwriters in a lot of administration. This causes delays to customers, increases costs and introduces the possibility of human error. From a customer service perspective, this all increases the risk of disputes down the line when our customers need us to step up and fulfil our commitments.

DLT can transform this process by using trusted, automated methods to collate, assimilate and distribute the necessary information. It will lead to greater transparency as well as a simplified and faster process. In property insurance, the technology could provide an underwriter with immediate access to land registry records, validation of property details and ownership, access to local authority search data outlining, say, flood or subsidence risks, as well as building regulation records for details of the type and sustainability of construction materials. It could help in reviewing meteorological history to assess the potential for weather-related issues such as earthquakes, winds, storms or snowfall.

It can also help drive out fraud, as it could help with the validation of items to be covered and provides checks on provenance and ownership.

So that is the vision for the underwriting and pricing side. With regard to claims, traditional handling processes often allow for a disagreement between the insured and the insurer over what information has been shared and whether that information is valid and appropriate. This can lead to delays in settling claims. Not only is this expensive for everybody, but it can end up, in the worst case, in lengthy and costly litigation. So there is a real opportunity there in terms of claims management.

Smart contracts held on a distributed ledger could also improve efficiency while providing for increased contract certainty. We have looked at the potential for automatic payouts to be made against insured events without the need for an insured to even submit a claim given the right circumstances.

From a consumer perspective, implementation of distributed ledger technology across the sector could increase choice and competitive prices, improve coverage of policies and enable customers to create global identities which could be shared across the entire industry and beyond.

However, there are potential challenges as well. As with any technology, positive applications of DLT can introduce new types of risks, depending on the type of network. Permission list networks allow public visibility of online transactions and are available for broad participation. They are generally managed by a gatekeeper or a custodian who controls access: these are our private networks.

Permission list networks can be undermined by insufficient governance. There may be a lack of appropriate central control, transactions could be open to dispute while some people may not be happy with the relative lack of anonymity on that network.

On the other hand, permissioned or closed networks may provide a barrier to market entry. We have such a vibrant market with so many participants that closed networks could reduce operational transparency as well as network security.

Digital risks

There are other digital risks from the large-scale adoption of DLT. If we do adopt smart contracts, a coding error that automatically generates (or declines) a claim payment could undermine trust in the service. We need to be sure that it can be scalable and interface with other technologies – also that security is effective, especially at, for example, user devices and connections to external systems.

While consumers may be concerned that the technology leaves their own data more exposed because it is much more transparent, the reality is that it could actually improve data security. With data currently held and passed between different parties, this presents vulnerabilities. However, by creating a single platform with encrypted access, the likelihood of any breach is reduced.

A fundamental tenet of DLT is the immutability of the data in the ledger so that it cannot be changed once it has been validated and bound to the ledger. With ledgers being distributed across the entire network and potentially available to all network participants, it really is important that we address privacy concerns. Implementing the tightest possible security controls would be key to protecting both the data and the reputation of businesses that use DLT.

UK and international regulators are collaborating with the aim of ensuring a coordinated approach, given the global nature and scope of DLT applications and the businesses that are looking to implement them.

The new technology could enable a radical rationalisation by removing the need for each party to update data continually.

While consumers may be concerned that the technology leaves their own data more exposed, the reality is that it could improve data security.

Blockchain and distributed ledger technology are a fundamental part of the London insurance market's modernisation initiative.

Across the industry, companies are starting to band together on specific blockchain and distributed ledger initiatives, for example AXA and some of its partners have invested a reported \$55 million in a blockchain start-up. In 2017, a number of global insurers and reinsurers, including Allianz, Munich Re, Swiss Re and Zurich, launched their own initiative to explore the potential. Allianz has also successfully piloted a smart contract to automate swap transactions on catastrophe risks.

Blockchain and DLT are a fundamental part of the London insurance market's modernisation ini-

tiative. A number of use cases have been developed and a number of pilots are looking at various areas.

The technology is almost the smaller challenge. The bigger one is working with 350 firms and their CEOs, their CIOs and their COOs to agree which approach we are going to take for the whole market. Actually, in my view that is going to be the biggest challenge of all.

We are expecting to move very shortly from pilots and proof-of-concepts to real-world global deployments of Distributed Ledger Technology, using this technology to improve customer service – and that is the first priority. □

The ability to identify and track billions of devices

Mike Short



Professor Mike Short CBE FREng FIET is Chief Scientific Adviser at the Department for International Trade. He has been Chairman of the Global GSM Association, Board member of the WAP FORUM, founder Board member of Open Mobile Alliance (OMA) and Chairman and Honorary President of the UK Mobile Data Association. He has been a member of the UK Home Office Internet Task Force, Ofcom Spectrum Advisory Board and the Home Access to Broadband Committee. He is a past President of the Institution of Engineering and Technology (The IET).

Distributed Ledger Technology is important to this country because the UK is the leader in financial technology (Fintech) and DLT will be a key enabler for this in the future. The UK is also a leader in e-commerce and that quickly brings into play areas where DLT and indeed blockchain could make a real difference, whether it is in identity management or provenance. As the leading player in these areas, UK trade should support exports, collaboration and in some cases inward investment – and that is what the Department of International Trade seeks to do.

As a Chief Scientific Adviser I am part of a 'distributed ledger' of chief scientists, if that is the collective term! We have a coordinating function across different Government Departments, meeting regularly and discussing areas of science and engineering that influence the role of Government. Two and a half years ago, a report the Government Office of Science looked at the development of DLT and blockchain. It sparked a series of activities across Government to raise understanding in this area. Here, I want to outline the potential impact on the telecommunications industry.

There are nine billion mobiles in use today. That includes not just people with their phones, but also meters that may be connected via mobile networks around the world. Many people have more than one device and it is estimated there are 5.22 billion unique mobile users today. It is the most widely-adopted technology on the planet.

It might seem that the mobile industry already has plenty of identity management – the mobile

SUMMARY

- Distributed Ledger Technology will be a key enabler for Fintech, in which the UK is the world leader
- E-commerce will benefit greatly from DLT and blockchain
- DLT has great potential in mobile phone technology
- Keeping records of billions of interconnected items – as will be the case in the Internet of Things – will need blockchain
- As this area develops, it will need to move to greater standardisation.

phone number, perhaps even the identity of the mobile device itself – but mobile operators are already thinking about how to ensure that identity management works for people when they access the internet through smartphones, whether that involves health records or secure e-commerce.

This technology may also be able to lower the costs of telecommunications, increase competition and improve access. Another possibility is to improve customer services with automatic identification of individuals dialling in.

To take the example of mobile money, in December 2012 there were 136 million users but by December 2017 that had risen to 690 million users. These systems now process more than a billion dollars a day using text messages authenticated to

confirm a money transfer. Of that figure, Sub-Saharan Africa accounted for 49% and Southern Asia 34%, but there is significant growth in the Middle East, North Africa and the Caribbean.

Mobile money, because of its volume, is an important area from a security point of view. While operators are now using simple SMS or texting, they are starting to think about introducing blockchain. The mobile money technology is, after all, sending large remittances from country to country, so the question of how to improve security is always relevant.

So the mobile industry is looking to use blockchain in the area of money transfer, perhaps also credit checking. Other aspects include actual payment as well as money transfer – how can payment be made more efficient? How can receipts be made more efficient? That quickly comes back to provenance of payment and provenance of credit records – getting better access to those records for many users and for many purposes. E-commerce will depend very heavily on that.

Record-keeping

Another area where blockchain may be of increasing importance is in record-keeping. Individuals might wish to control who has access to their education and health records, while it may be very important for clinicians or careers advisers to be able to consult them. Blockchain or DLT may be able to provide both restricted access and security.

Again, it is vital to track the provenance of food and other goods and value chains – blockchain might help with the identity management here so that the relevant people can check provenance, date, origin and other aspects of a value chain.

For decentralised organisations, there is real potential with the need for centralised, verifiable record-keeping with restricted decentralised access.

One of the rapid growth areas will be in the Internet of Things, where more and more devices and objects are being connected, not just people. Taking all types of connection technologies (wireless, wifi, fibre), around 7.5 billion things currently have a connected element to them and that is expected to grow to about 25.1 billion. That is going to require different types of decentralised databases to share verification (and perhaps reconciliation) information in order to make sure, in commercial transactions, that the relevant bill goes to the right person. And given the volumes, it has to be demonstrated that these technologies can operate at scale – very large scale!

Then there have to be relevant standards. There are a number of different and interesting approaches, but actually standardisation must emerge – and the emphasis will be on lowering

costs while optimising effectiveness. So we need scale, standards and security.

I recently visited a British company called Iris Guard, which has been developing eye recognition. It uses specialist camera technology that takes images of the iris to help authenticate the person. Eye recognition cameras, in conjunction with blockchain and cloud computing enable identification. They are currently using this with Syrian refugees in Jordan, who cannot easily be identified because they have lost their papers. It helps those refugees get money out of an ATM machine today, using this eye recognition technique. It is also linked to the World Food Programme so that they can access food. That is a real-life example today. There is a lot more to be done though, in demonstrating the value of the technology through large-scale examples, not just small-scale projects. □

FURTHER INFORMATION

2016 report by the UK Government Chief Scientific Adviser

Distributed Ledger Technology: beyond block chain

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/492972/gs-16-1-distributed-ledger-technology.pdf

House of Lords report – November 2017 ***Distributed Ledger Technologies for Public Good: leadership, collaboration and innovation***

http://chrisholmes.co.uk/wp-content/uploads/2017/11/Distributed-Ledger-Technologies-for-Public-Good_leadership-collaboration-and-innovation.pdf

Gresham College Public Lecture - January 2018 ***Will Bitcoin and the Blockchain change the way we live and work? Professor Martyn Thomas CBE***

www.gresham.ac.uk/lectures-and-events/will-bitcoin-and-the-block-chain-change-the-way-we-live-and-work

GSMA Report Refugees and Identity: Considerations for mobile-enabled registration and aid delivery

www.gsma.com/mobilefordevelopment/wp-content/uploads/2017/08/TWP81_1_DigitalIdentityProgrammeReport_WebSingles_R.pdf

IBM Reports Bridging the divide: How CLS and IBM moved to blockchain

www-935.ibm.com/services/us/gbs/thoughtleadership/bridgingdivide/

Unblocking the blockchain

www-935.ibm.com/services/us/gbs/thoughtleadership/unblocking/

Blockchain rewires financial markets

www-01.ibm.com/common/ssi/cgi-bin/ssialias?htmlfid=GBP03469USEN

Thought leadership from the IBM Institute of Value

www-935.ibm.com/services/us/gbs/thoughtleadership/blockchainlibrary.html

Blockchain in the real world



Keith Bear, Vice President, Global Financial Markets, IBM, joined the panel for the discussion period.

I, with the Chair of the National Fire Chiefs Council Roy Wilsher, Sir Ken Knight and the President of the Royal Institution of Chartered Surveyors Amanda Clack, was called into Whitehall within days of the fire and asked to join the Government's Expert Panel.

The question of trust is fundamental to what blockchain, or DLT, brings as a technology. It can bring trust to networks or communication where that may not exist, or only partially exists. This is delivered through a consensus between participants that an event or a transaction has happened – and that it has been executed securely with adequate encryption and then written irrevocably to the ledger.

How then do these technologies actually make an impact in the real world? IBM conducted a survey in 2016 with 200 banks. At the time, around 14% thought that they would have a blockchain network in place by early 2018. In reality, while the number may be less, this year sees a significant transition from Proof of Concept to Production.

The good news is that new blockchain business networks are taking shape. In Europe, nine banks (including HSBC here in UK) have formed a consortium aimed at trade finance for SMEs. There are more than 20 million SMEs in Europe and 70% of them trade just within their own national borders. So, anything that encourages them to trade across Europe and encourages the banks to provide more finance to help them can only be a good thing.

On the regulatory side, in terms of increasing understanding in the industry about the technology and in terms of encouraging its adoption, a benign and supportive regulatory environment is really critical to many of the initiatives currently being undertaken.

As an example, IBM is working with Northern Trust on a Guernsey-based fund where the Guernsey regulator now has a node on the blockchain network. They have visibility of everything within that environment and all the benefits that transparency brings to a regulator as a result of participating directly in the launch of the network. □

The debate

The discussion after the formal presentations covered a wide range of subjects including: data protection; network keys; new entrants; and public sector involvement.

There could be a conflict between the new European General Data Protection Regulation (GDPR), with associated rights to be forgotten, and the basic principles of DLT which identifies participants. The solution may depend on how ledgers are created, with the potential separation of personal data from other information. There were precedents for doing so in the mobile phone sector, which facilitates police access to data in a manner compliant with legislation.

System vulnerability

One key system vulnerability of DLT relates to cryptography, and the management of public and private keys. Any distributed network will be as weak as its weakest network. In some sectors it may be the regulator who becomes the trusted entity managing network keys.

New entrants can be expected to challenge established players. The time it will take to replace complete legacy systems in financial markets may protect the latter for some time, though. Although the UK has started strongly in DLT, European competitors are gaining ground, for example in

Fintech in Berlin and in shipping in Rotterdam. Relevant standards are being set elsewhere.

A strong UK response involving innovation labs has attracted strong interest. The UK Government's commitment to a significantly rising R&D budget is also helpful. A strong continuing position for the UK will require the right approach to data across European borders after Brexit.

Can public sector collaboration with the private sector promote the adoption of DLT? There are important opportunities in land registration, automatic number plate recognition and broadly in provenance. Potential applications include global supply chains (particularly in shipping), food provenance, international payments and land ownership. Perhaps there is scope for DLT in the health sector, where public confidence will need to be very high in the light of concerns about the security of patient records.

DLT will be deployed well before the breadth of its implications is understood. It might soon allow traditional financial auditing to be substantially simplified. Some 10% of UK Fintech already focusses on blockchain. □

Presentations and audio recordings from all meetings of the Foundation for Science and Technology are available at: www.foundation.org.uk

How can the adoption of new technology be accelerated to improve the efficiency of the justice system? - The Rt Hon Sir Brian Neill Memorial Debate

20 June 2018

The Rt Hon Sir Geoffrey Vos, Chancellor, The High Court of England and Wales, Royal Courts of Justice

Susan Acland-Hood, Chief Executive, HM Courts & Tribunals Service

Professor Richard Susskind OBE FRSE, President, The Society for Computers and Law

Andrea Coomber, Director, Justice [Panellist]

Is the rate of change of GDP the best way to measure economic growth?

23 May 2018

Professor Jonathan Haskel CBE, Professor of Economics, King's Business School, King's College London

John Pullinger CB, National Statistician, Head, Government Statistical Service and Chief Executive, UK Statistics Authority

Tera Allas, Senior Fellow and Director of Research, McKinsey Center for Government

Clare Lombardelli, Chief Economic Advisor to the Treasury and joint head of the Government Economic Service, HM Treasury [Panellist]

Professor Martin Weale CBE, Professor of Economics, King's Business School, King's College London [Panellist]

Professor John Kay CBE FRSE FBA, Economist [Panellist]

The impact of distributed ledger technology on trading, finance and insurance

25 Apr 2018

Chris Corrado, Group Chief Operating Officer and Chief Information Officer, London Stock Exchange Group

Shirine Khoury-Haq, Chief Operating Officer, Lloyd's of London

Dr Mike Short CBE FREng FIET, Chief Scientific Adviser, Department for International Trade

Keith Bear, Vice President, Global Financial Markets, Global Markets, IBM [Panellist]

Tim Smith, Consultant, Credit Suisse [Panellist]

Securing environmental benefits from farming while meeting the demand for food

21 Mar 2018

Professor Ian Boyd FRSE FRSB, Chief Scientific Adviser, Department for Environment and Rural Affairs

Minette Batters, President, National Farmers Union (NFU)

Helen Browning, Chief Executive, Soil Association

The Lord Cameron of Dillington, House of Lords [Panellist]

Richard Hebditch, Government Affairs Director, The National Trust [Panellist]

UKRI leaves the starting blocks: the management of government funding of research and innovation

28 February 2018

Sir Mark Walport FRS FMedSci HonFRSE, Chief Executive, UKRI

Sir Alan Wilson FBA FRS, Chief Executive, the Alan Turing Institute

Kirsten Bound, Executive Director of Research Analysis and Policy, NESTA [Panellist]

Jonathan Neale, Chief Operating Officer, McLaren Technology Group Ltd [Panellist]

The Hackitt Review of Building Regulations and Fire Safety

24 January 2018

Dame Judith Hackitt DBE FREng, Chair, Hackitt Inquiry into Building Regulations and Fire Safety

Graham Watts OBE, Chief Executive, Construction Industry Council (CIC)

Peter Baker, Director, Construction Division and Chief Inspector of Construction, Health and Safety Executive

Dr Peter Bonfield OBE FREng, Member, Grenfell Expert Panel, Ministry of Housing, Communities and Local Government and Chief Executive, BRE Group [Panellist]

Turlogh O'Brien CBE, Chairman of the Governing Board of the Chartered Institute of Housing and Post-Grenfell Expert Working Group, Construction Industry Council (CIC) [Panellist]

The impact on society of machine learning – an opportunity or a threat?

14 November 2017

Dr Mike Lynch OBE FRS FREng, Founder, Invoke Capital

Dr Claire Craig CBE, Director of Science Policy, The Royal Society

Amir Saffari, Head of AI, BenevolentAI

Dame Wendy Hall DBE FRS FREng, Regius Professor of Computer Science, University of Southampton

Professor Chris Bishop FRS FREng, Laboratory Director, Microsoft Research, Cambridge [Panellist]

A business strategy for Scotland

6 November 2017

Professor Iain Gray CBE FREng FRSE, Vice

President for Business, The Royal Society of Edinburgh

Nora Senior CBE, Chair, Scottish Government's Strategic Board for Enterprise and Skills

Dame Susan Rice CBE FRSE, Chair, Scottish Water

Paul Wheelhouse MSP, Minister for Business, Innovation and Energy and Member for South Scotland, Scottish Parliament

Searching for the Holy Grail of a science and innovation strategy that makes a difference

18 October 2017

The Lord Hennessy of Nympsfield FBA, House of Lords

The Rt Hon the Lord Heseltine CH, House of Lords

The Rt Hon the Lord Willetts, Executive Chairman, The Resolution Foundation

Cancer diagnostics: can cancer be diagnosed earlier and if yes what are the consequences?

11 July 2017

Sir Harpal Kumar, Chief Executive, Cancer Research UK

Billy Boyle, Chief Executive Officer, Owlstone Medical

Dr Clare Turnbull, Clinical Lead, Genomics England 100,000 Genomes Cancer Programme

Dr Suzanne Jenkins, Diagnostics Expert (Director), Personalised Healthcare and Biomarkers, AstraZeneca [Panellist]

Sara Hiom, Director of Early Diagnosis and Health Professional Engagement, Cancer Research UK [Panellist]

The impact of demographic and medical trends on the health and social care systems of the UK

21 Jun 2017

Professor Chris Whitty CB FMedSci, Chief Scientific Adviser, Department of Health, Deputy Government Chief Scientific Adviser

Sir Robert Lechler PMedSci, President, Academy of Medical Sciences

Professor Marcel Levi, Chief Executive, University College London Hospitals NHS Foundation Trust

Making cities work - the application of technology, science and infrastructure improvements to create a place where citizens wish to live

24 May 2017

Professor The Lord Mair CBE FRS FREng, Sir Kirby Laing Professor of Civil Engineering, Department of Engineering,

EVENTS

University of Cambridge
Tom Saunders, Principal Researcher,
International Innovation, Nesta
Councillor Peter Marland, Leader, Milton
Keynes Council

What constitutes an effective industrial strategy for the UK?

10 May 2017

Professor Graeme Reid, Specialist Adviser
to the House of Lords Select Committee on
Science and Technology
**Professor Dame Ann Dowling DBE FRS
FREng**, President, Royal Academy of
Engineering
Andrew Barker, Head of Investor Relations,
International Airlines Group
Anthony Lilley OBE, Chief Executive and
Chief Creative Officer, Magic Lantern
Dr Andrew Harter FREng FIET FBCS,
Chair, Cambridge Network and Founder
and CEO, RealVNC [Panellist]

What needs to be done to meet urban air quality targets and what are the consequences if the targets are not met?

26 Apr 2017

Elliott Treharne, Air Quality Manager,
Greater London Authority
Dr Stephen Bryce, Vice-President, Fuels
Technology, Shell Projects and Technology
Professor Frank Kelly, Professor of
Environmental Health, King's College
London
Dr Christa Hasenkopf, Chief Executive and
Co-Founder, OpenEQ [Panellist]

How can skill levels be raised to meet the needs of society and the economy?

1 March 2017

Sir Mark Walport FRS FMedSci,
Government Chief Scientific Adviser,
Government Office for Science
Sir Adrian Smith FRS, Chair of the Smith
Inquiry into mathematics education for 16
to 18 year olds and Vice Chancellor of the
University of London
Dame Judith Hackitt DBE FREng, Chair,
EEF (formerly the Engineering Employers'
Federation)
Stephen Metcalfe MP, Chair, House of
Commons Select Committee on Science and
Technology [Panellist]

Making good use of science and innovation in overseas development programmes

14 December 2016

Professor Charlotte Watts FMedSci, Chief
Scientific Adviser and Director Research
and Evidence Division, Department for
International Development
Jon Ridley, Head, M-KOPA Labs, M-KOPA
Solar
Rowan Douglas CBE, Chief Executive, Capital,

Science & Policy Practice and Chair, Willis
Research Network, Willis Towers Watson

The opportunities for and threats to the research and innovation communities from Brexit

16 November 2016

Sir Venki Ramakrishnan PRS FMedSci,
President, The Royal Society
Professor Louise Richardson FRSE, Vice-
Chancellor, University of Oxford
The Rt Hon the Lord Willetts, House of Lords
Dr Hermann Hauser KBE FRS FREng,
Co-Founder, Amadeus Capital Partners
[Panellist]
Professor Madeleine Atkins CBE, Chief
Executive, Higher Education Funding
Council for England [Panellist]

The vision for UK Research and Innovation (UKRI)

9 November 2016

Sir John Kingman KCB, Chair, UK Research
and Innovation, Department of Business,
Energy and Industrial Strategy
**Professor Dame Julia Goodfellow DBE
FMedSci**, President, Universities UK and
Vice-Chancellor, University of Kent
Phil Smith, Chair, Cisco UK & Ireland, Chair,
Innovate UK and Chair, The Tech Partnership

Health, happiness and wellbeing: supporting the transition from adolescence to adulthood

26 October 2016

Dr Joanne McLean, Research and
Development Manager, Scotland, Mental
Health Foundation
Dr Helen Sweeting, Reader, MRC/CSO
Social and Political Health Sciences Unit,
University of Glasgow
Lord Layard FBA, Director, Wellbeing
Programme, Centre for Economic
Performance, London School of Economics
and Political Science
Catherine Calderwood FRCP, Chief
Medical Officer for Scotland, Scottish
Government [Panellist]

The National Flood Resilience Review: the lessons learned from recent flood events in the United Kingdom

12 October 2016

Professor Dame Julia Slingo DBE FRS,
Chief Scientist, Met Office
Dr Doug Wilson, Director, Scientific &
Evidence Services, Environment Agency
Simon Warsop, Chief Underwriting Officer,
Personal Lines, Aviva
Professor Charles Godfray CBE FRS, Chair,
Defra Science Advisory Council and
University of Oxford
Professor Bas Jonkman, Professor of
Integral Hydraulic Engineering, Delft
University of Technology

Katharine Hammond, Director, Civil
Contingencies Secretariat, Cabinet Office

What is the value to the economy of the finance and insurance sectors?

6 July 2016

Anne Richards CVO CBE FRSE, Chief
Executive, M&G Investments
John Nelson, Chairman, Lloyd's of London
Professor John Kay CBE FRSE FBA,
Economist and *Financial Times* Columnist

How should universities and Research Councils proactively respond to gender bias in success rates in grant applications?

22 June 2016

Professor Paul Boyle CBE FBA FRSE,
President and Vice-Chancellor, University
of Leicester
Professor Henrietta O'Connor, Deputy
Head of College of Social Science, Arts and
Humanities and Professor of Sociology,
University of Leicester
Linda Holliday, Director of Capacity and Skills
Development, Medical Research Council

Is a paradigm shift taking place in the ways individuals and organisations access, analyse and protect data?

25 May 2016

Professor Sir Nigel Shadbolt FREng, Chairman
and Co-Founder, The Open Data Institute
Dr Mike Lynch OBE FRS FREng DL, Founder,
Invoke Capital
Professor David Hand OBE FBA, Chief
Scientific Adviser, Winton Capital
**Baroness O'Neill of Bengarve CH CBE FBA
HonFRS FMedSci**, House of Lords [Panellist]

The pros and cons of EU membership for UK research programmes in private enterprises and public sector organisations

3 May 2016

The Lord Hennessy of Nympsfield FBA,
Member, House of Lords Science and
Technology Select Committee, House of Lords
Viscount Ridley FMedSci FRSL, Member,
House of Lords Science and Technology
Select Committee, House of Lords
**Professor Dame Jocelyn Bell Burnell DBE FRS
FRSE FRAS FInstP**, President, The Royal
Society of Edinburgh
Sir Emyr Jones Parry GCMG FInstP FLSW,
President, The Learned Society of Wales

Building effective and efficient infrastructure for the UK

27 April 2016

Tony Meggs, Chief Executive, Infrastructure
and Projects Authority, Cabinet Office
The Rt Hon The Lord Adonis, Chair, National
Infrastructure Commission
Sir Terry Morgan CBE, Chairman, Crossrail
Darren James, Managing Director,
Infrastructure, Costain [Panellist]

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G Genomics England Geological Society GSK	P Palaeontological Association Parliamentary and Scientific Committee Penningtons Manches LLP Phrasee	
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