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Professor Paul Boyle

Professor Henrietta O'Connor

Linda Holliday

THE FOUNDATION FOR SCIENCE AND TECHNOLOGY

COUNCIL

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Select Committee warning over the future of Innovate UK

In a letter to the Science Minister, Jo Johnson MP, the Chairman of the House of Lords Science and Technology Select Committee, the Earl of Selborne, says the Committee believes that plans to incorporate Innovate UK into UK Research and Innovation (UKRI) are wrong and endanger its important business-facing focus.

The letter also says they are not convinced of the merits of moving from grants to loans as a means of funding, and that the integration of the two bodies is not a natural fit.

Finally, the letter urges the Government to make sure there are safeguards in place, should the proposals for a merger go ahead, which would protect the key strengths of Innovate UK, namely autonomy, its funding, and its focus on encouraging innovation through business.

Lord Selborne commented: "Our first concern over these proposals is what we see as a poorly researched and too narrow premise. It was not clear to us the Government had a strong and clear evidence base with which to put this restructure on the table, and we believe it then failed to consult properly before developing its white paper.

"But more importantly we think that the plans are not sound. We believe that Innovate UK would lose its valuable business-facing focus if it were to be placed within UK Research and Innovation, and the consequences could be damaging. We urge the Government to think again."

www.parliament.uk/business/committees/committees-a-z/lords-select/science-and-technology-committee

Johnson reappointed as Science Minister

Jo Johnson has been reappointed as the Minister with responsibility for universities and science, in the reshuffle following the appointment of Theresa May as Prime Minister. However, as the remit for Higher and Further Education has been transferred to the Department for Education, he will hold the post of joint Minister of State in both DfE and in the new Department for Business, Energy and Industrial Strategy which retains the Science brief.

The new Business Secretary, Greg Clark, is himself a former Minister for Universities and Science, having held that post from July 2014 until the last General Election, after which he became Secretary of State for Communities and Local Government.

Researchers develop world's tiniest engine

Researchers have developed the world's tiniest engine – just a few billionths of a metre in size – which uses light to power itself. The nanoscale engine, developed by researchers at the University of Cambridge, could form the basis of future nano-machines that can navigate in water, sense the environment around them, or even enter living cells to fight disease.

The prototype device is made of tiny charged particles of gold, bound together with temperature-responsive polymers in the form of a gel. When the 'nano-engine' is heated to a certain temperature with a laser, it stores large amounts of elastic energy in a fraction of a second, as the polymer coatings expel all the water from the gel and collapse. This has the effect of forcing the gold nanoparticles to bind together into tight clusters. But when the device is cooled, the polymers take on water and expand, and the gold nanoparticles are strongly and quickly pushed apart, like a spring.

Nano-machines have long been a dream of scientists and public alike, but since ways to actually make them move have yet to be developed, they have remained in the realm of science fiction. The new method developed by the Cambridge researchers is simple, but can be extremely fast and exert large forces.

The forces exerted by these tiny devices are several orders of magnitude larger than those for any other previously produced device, with a force per unit weight nearly a hundred times better than any motor or muscle. According to the researchers, the devices are also bio-compatible, cost-effective to manufacture, fast to respond, and energy efficient.

Lack of cybersecurity may threaten confidence in digital services

Public trust in digital services and the ability of the digital economy to continue to thrive could be at risk in the UK without a step change in cybersecurity, supported by action from Government, business and researchers, according to a new report by the Royal Society.

This will require an ambitious programme of research and innovation to generate new security approaches and products, as well as establishing clear standards and kitemarks to help users identify trustworthy digital products and services.

Progress and Research in Cybersecurity also calls for: a review of the oversight structures for cybersecurity in the UK, looking forward to what will be needed in the next five to 10 years, as the emphasis shifts between state security concerns and personal data security issues; and Government commitment to preserving the robustness of encryption and promoting its use.

"Digital systems are increasingly integrated into our lives and digital industries in the UK grew 32% faster than the rest of our economy between 2010 and 2014," said Professor John McCanny, co-chair of the Royal Society working group who wrote the report.

He added: "But with technology developing at a spectacular pace, the security that protects us and our data is at times struggling to keep up. We need to maintain public trust in the systems we rely on. That means organisations need to invest more in cybersecurity, as well as demonstrate how secure they are to earn the trust of users."

royalsociety.org/topics-policy/projects/cybersecurity-research

ASC report predicts impacts of climate change on the UK

The impact of climate change is already being felt in the UK, and urgent action is required to address climate-related risks, the Adaptation Sub-Committee (ASC) of the UK's Climate Change Committee has said.

The ASC's independent report to Government, *UK Climate Change Risk Assessment Evidence Report* sets out the most urgent risks and opportunities arising for the UK from climate change.

The result of more than three years' work involving hundreds of leading scientists and experts from the public and private sectors and civil society, the risk assessment has been peer-reviewed by UK and international specialists.

Effects are likely to include periods of too much or too little water, increasing average and extreme temperatures, and sea level rise. The most urgent risks resulting from these changes are:

- risks to health, wellbeing and productivity from high temperatures;
- shortages in the public water supply, and water for agriculture, energy generation and industry, with impacts on freshwater ecology;
- risks to natural capital, including terrestrial, coastal, marine and freshwater ecosystems, soils and biodiversity;
- risks to domestic and international food production and trade;
- flooding and coastal change risks to communities, businesses and infrastructure;
- new and emerging pests and diseases, and invasive non-native species.

There are opportunities for the UK as well. UK agriculture and forestry may be able to increase production with warmer weather and longer growing seasons, if constraints such as water availability and soil fertility are managed. There may be economic opportunities for UK businesses from an increase in global demand for adaptation-related goods and services, such as engineering and insurance.

www.theccc.org.uk/uk-climate-change-risk-assessment-2017

Keeping an ageing workforce productive

The proportion of the working age population aged between 50 and the state pension age (SPA) will increase from 26% in 2012 to 35% in 2050 – an increase of approximately 8 million people, according to a new report from the Government Office for Science. This is the result of increases to the SPA, as well as the so called 'baby boomers' reaching this age band.

The Foresight report, *Future of an Ageing Population*, notes that productivity and economic success of the UK will therefore be increasingly tied to the productivity and success of its ageing workforce.

Encouraging older people to remain in work will help society to support growing numbers of dependents, while providing individuals with the financial and mental resources needed for longer periods of retirement. The employment rate currently declines from 86% for 50 year olds, to 65% for 60 year olds and 31% for 65 year olds.

The report notes that "Responding to this demographic shift will require us to make adaptations across many aspects of our lives: how we work; how we care for, communicate and interact with each other; the built environment we live and work in; the way we live our lives; how we learn; and how we use technology. We need to understand the nature and implications of this population change in order to adapt successfully."

www.gov.uk/government/publications/future-of-an-ageing-population

Wellcome Trust taskforce for patient data

The Wellcome Trust is setting up an independent taskforce in response to new recommendations by Dame Fiona Caldicott, the National Data Guardian, on the use of patient data.

Information from health records has a huge potential to improve healthcare delivery and advance medical research. But it is essential that people have confidence in the way their data is managed and assurance over how it will be used.

At the moment, there is very low awareness around how data can be used within the NHS, says the Trust.

The new taskforce will build on the work of the Caldicott Review, helping to develop a framework for clear and transparent discussions with the public, patients and healthcare professionals about how data can be used to improve health. It will develop innovative approaches and tools to encourage more effective dialogue and communication.

Jeremy Farrar, Director of Wellcome, said: "We will only unlock the immense value of patient data if we have open and honest discussions about how and why data can be used for care and research."

Research and the EU

Following the recent referendum in which a majority chose to leave the European Union, Research Councils UK issued a statement. It said:

"The UK's excellence in science and research is well established and UK researchers are sought after collaborators internationally. The success of UK research is dependent on our best researchers collaborating with partners and sharing facilities across international boundaries. We are committed to enabling and facilitating these collaborations between UK researchers and international partners in Europe and across the world.

"Following the UK's referendum vote to leave the European Union we are working with our research communities and with Government to ensure that the UK is well placed to maintain its place as a leading research nation. While the UK remains a full member of the European Union we encourage researchers to continue to engage with partners in the EU and with European funding schemes as normal. The Research Councils recognise that there is uncertainty about the future of the UK's relationship with the EU in general and specifically affecting aspects of the research system. We are working with Government to ensure that the concerns and needs of UK researchers are represented and are considered in the negotiation of a future relationship with the EU."

www.rcuk.ac.uk

Science after the Brexit vote

David Willetts

The Rt Hon the Lord Willetts joined the Resolution Foundation as Executive Chair in June 2015. He was Minister for Universities and Science, attending Cabinet, from 2010-2014. Lord Willetts is Chair of the British Science Association. He is a Visiting Professor at King's College London, Governor of the Ditchley Foundation and a member of the Council of the Institute for Fiscal Studies. He was the Member of Parliament for Havant from 1992-2015. He also served as Paymaster General in the last Conservative Government. Lord Willetts is a Council member of the Foundation for Science and Technology.

Brexit came as an enormous shock to many of us in the science and technology community. It will lead to far bigger changes in our country than most General Elections do. The research community is normally pretty disputatious, but it was overwhelmingly in favour of Remain. However, voters do not appear to have been listening and this makes it an even more painful double-rejection by the electorate – not just of the EU but of the views of the science community.

We failed to persuade voters how much the vigour of our universities and the openness of our research labs depends on the flow of people across national borders. The gap between scientists and the wider community is too wide and we need renewed efforts to bridge it – one of our priorities at the British Science Association.

The case to remain

Sometimes the case that was being made for staying in the EU sounded very transactional and financial – simply that the British research community gets more money from the EU than we put in. But that made it easy for the Brexiters to argue that the lost funds could be replaced out of our net EU Budget contribution.

Now there is a real policy decision. One option is indeed to aim for an increase in domestic spending to match the almost £1 billion of net EU funding which will be lost. The other option is to opt back in to EU science programmes such as Horizon 2020 with an arrangement like, for example, Switzerland's. EU funding actively promotes the linking of researchers and institutes, so remaining in their programmes would keep us within these networks.

The trouble is that some form of free movement of people would probably be a pre-condition – the Swiss have already had difficulties since a referendum of their own which limited freedom of movement. However, we should not give up on the idea before we have even started negotiations. If the science community would prefer this option, then a strong and coherent case needs to be presented.

Strengthening global links

We will also need to strengthen our global links still further. The Newton Fund and now the Global Challenges Research Fund are opportunities which we must use to the full. The Brexiters argued that our membership of the EU stopped us being more global. Yet there is no reason why our membership of the EU should have held us back: it did not hold back other member states. Whenever I tried to help open up closer links with scientists and technologists from China to Mexico, I would often find that the Germans had already been there before us.

There are many other networks, of course, which stretch way beyond the EU – from the Large Hadron Collider at CERN to nuclear fusion in the ITER project. I was keen to see us playing a leading role in as many such collaborations as possible, provided the quality of the science justified it.

We are important partners in the Square Kilometre Array (SKA) which will be run out of Jodrell Bank. We have now become full partners in the International Spallation Source which provides a neutron source that complements the electron-based Diamond Light Source at Harwell. Tim Peake's mission to the International Space Station is evidence of how we have boosted our role in the European Space Agency (ESA). Greg Clarke got us an excellent settlement at the last ESA ministerial in 2014 and now we must hope for a similar performance later this year.

These official institutions are just part of the networks to which our scientists and research belong. We need them more than ever. One way we can all offset the effects of Brexit is to work hard to keep them active and to strengthen them. Talking to a rueful David Cameron after the result, he told me how leaving the EU must not mean that we turn our backs on Europe and sever all links with them. That must be right.

New opportunities

Even though I very much wanted us to Remain, there are actually some opportunities which can now open up to us. We all know that we need to do better at commercialising our excellent research. One barrier has been the difficulty of locating publicly funded research and commercial facilities in the same building.

VAT rules require that if more than 5% of a building is for commercial use then the whole building costs bear VAT. I have been to facilities where the commercial incubator space has had to be built separately as a result of this constraint which goes back to EU rules. There is now an opportunity to change it.

NASA

The presence on the International Space Station of Tim Peake (left), has boosted the UK's role in the ESA.

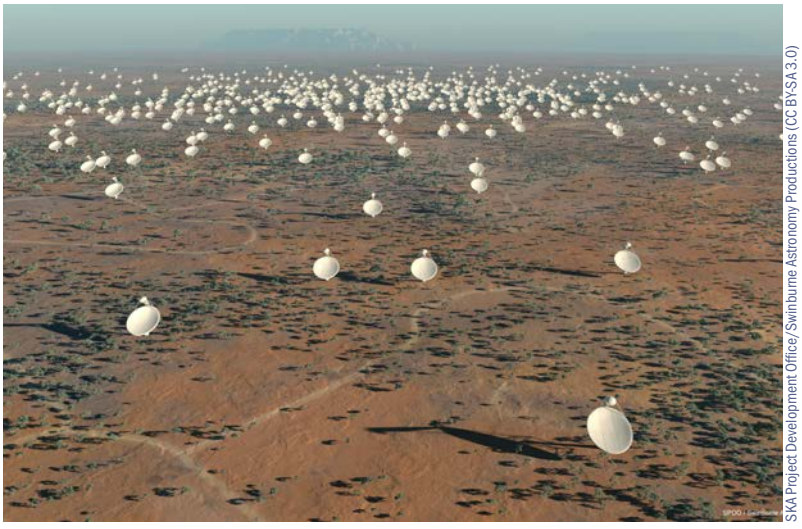
EU regulations have also been a barrier to innovation in crucial areas. The EU's approach to GM crops is immoral – making it harder for developing countries to feed their growing populations even though the scientific evidence is overwhelmingly that GM is safe. Now we can take responsibility for this decision. It will be an important test case, as we will find to what extent we have been held back by the EU and to what extent it is our own home-grown anti-scientific lobbyists who are the problem.

There are other areas where the EU has been holding back scientific innovation. The proposed EU rules on data protection and privacy would have made some of the great advances in public health impossible by making it much harder to conduct research drawing on evidence about health conditions across the population as a whole. The Big Data revolution has been in danger of passing Europe by – we now have much more freedom to be part of it.

The Brüstle judgement, making it harder to patent embryonic stem cell development, has also had a dampening effect and we could now aim for a more liberal approach.

So we should not despair. There are important issues which are still open and to be decided. We must put even more energy into strengthening our international links. We might find new areas for innovation open up.

I am confident that the excellent team of Greg Clark and Jo Johnson are up to these challenges. Achieving the future we seek will require a much more effective effort than ever before to bring science into the mainstream of our national life. People must understand what it offers and what we need to do to support it, not just with money but with an open and diverse environment. □



SKA Project Development Office/Swinburne Astronomy Productions (CC BY-SA 3.0)

Artist's impression of the 5km diameter central core of SKA antennas.

Is a paradigm shift taking place in the ways in which individuals and organisations access, analyse and protect data? The topic was debated at a meeting of the Foundation for Science and Technology held on 25 May 2016.

Unlocking the potential of open data

Nigel Shadbolt

Professor Sir Nigel Shadbolt FREng is Chair of the Open Data Institute and Principal of Jesus College, Oxford. Sir Nigel co-founded the Open Data Institute, which specialises in the exploitation of open and other forms of data to support innovation, training and research both in the UK and internationally. He has persuaded Government to make many datasets available for analysis or for the development of new products and services by third parties.

SUMMARY

- Using open data standards to collect and analyse all types of data enables flexibility in the future, for example if the boundaries for that data were to change from private to shared.
- Open data have been invaluable in a variety of situations, from assisting humanitarian relief efforts after natural disasters to improving prescribing in the NHS.
- Open data should be seen as an essential part of the national infrastructure, similar to roads and power grids, and future data needs planned for.
- Innovation should not be stifled by data regulation, but used to solve problems such as concerns about the privacy of personal data.
- In the future, the current platform-centred nature of the web may give way to a decentralised system in which individuals, rather than companies, become the controllers of their own data.

Open data are an important feature of the modern data environment. They can be used in many settings and can yield enormous economic and social benefits. However, not all data are open. Some are highly sensitive and need to stay within well-controlled domains. This may be commercial data, personal data or Government data. Yet it is useful if open data standards are applied in the initial collection and analysis, even if access needs to be limited: open standards will allow for future interoperability in a way that proprietorial formats do not support. This would allow flexibility if the boundaries for that data shift – for example, if it moves from private to shared.

Benefits of open data

The benefits of open data can be seen most dramatically in the case of the devastating earthquakes that destroyed much of Port au Prince in Haiti and Kathmandu inNepal. With roads and buildings gone, the cities were almost unrecognisable and there were no maps to guide the emergency services. Using crowd-sourcing methods, satellite imagery, and information gained from open planning platforms, as well as from walking the streets with GPS systems, volunteers were able to create and annotate real-time maps of roads and buildings for the emergency services to use. This would not have been possible without the availability of open data.

Perhaps less dramatically, but importantly, open data have enabled the NHS to make large savings in drug costs. By analysing drug prescriptions, it was found that money was being spent unnecessarily by prescribing patented versions of some drugs when cheaper generic versions were available. In the case of statins, analysis determined that around £200 million per year could be saved by switching to generic versions. Another example is antibiotics, the prescribing of which has been dramatically lowered by the availability of open data to the prescribing community. Open data enabled an understanding of patterns of behaviour and delivered insights that led to benefits for everyone who uses the NHS.

In transport, large amounts of open data are aggregated to provide open platforms that others can use to run their services. For example, much of the transport data for London comes from Transport for London (TfL)'s open data feeds. These are used by other companies to develop apps that create economic and social value by enhancing our experience of travelling around London.

The benefits of open data can be seen most dramatically in the response to the devastating earthquake that destroyed much of Kathmandu.

National infrastructure

Open data can be categorised into various types, for example: contracts, administrative geography,

transport data and energy consumption. These types begin to form the fabric of a set of reference data about how the UK works and is run. Open data can be seen as part of the national infrastructure, just as valuable as roads and power grids. This becomes a core reference for the transaction of business in the UK. For example, Ordnance Survey data shows how the UK is administratively organised – postcodes, parishes, voting boundaries and so on – enabling us to freely link events to the administrative geography of the country.

Similarly, data from the Land Registry on historic prices for property transactions are now available for analysis and reuse. Data from Companies House, now provided free of charge, are enormously valuable and used by many Government departments. These items are all essential pieces of our infrastructure.

A challenge for Government is that these open data registers typically need investment. They must be supported and developed by the Government in order to be used for the public good. There is a danger that they might otherwise end up in private ownership.

We need to plan what type of data registers might be needed in the future, how many of these will require Government seeding and how many can be left for the private sector to develop. In permitting the private sector to develop some of these, we need to ensure that the data is genuinely open, although that does not necessarily mean that it would be free.

Songquan Deng / Shutterstock.com

TfL's open data feeds are used to create economic and social value

Open data as a global asset

The world is moving to a set of collected assets, many of which are licensed openly. One of the most interesting is Wikipedia, which is a distillation of facts about people, places and events. Many other data sets are aggregated and linked within Wikipedia. This approach is being used not just by Government but also by commercial entities. Similarly, much of Google has been harvested from open resources on the web. Often the data is enhanced and improved, and it is used for a wide range of purposes.

The future for personal data

We are now routinely offered devices such as personal fitness monitors whereby information about our daily behaviour is collected by various companies and third parties. The question naturally asked is: "Who has rights and access to that information and what are the responsibilities that come with that?"

In future, we might have our own personal data stores and be able to manage our personal data using flexible architectures that could act as points of contact for those wishing to use that data. Many issues could be addressed within such a system[1]. The citizen or consumer has to have a sense of ownership, or at least some level of empowerment, if we are not to have innovation stifled by regulation.

For example, worries over privacy led to European Court of Justice concerns about data retention and the adequacy of 'safe harbour' arrangements for EU citizens' data processed by US internet companies. I would rather see a situation where we promote innovation so that individuals become much more empowered by the data that governments and companies hold about them.

At the moment we live in a world that is essentially platform-centric, with extraordinarily powerful and successful companies offering very powerful services back to us, often as central information controllers. Imagine a world in which people owned, in a more substantial sense, their data assets and became their own data controllers. That would bring a different set of challenges. We need innovation not only to address the problems of today, but to meet new challenges in the future. □

[1] O'Hara K, Shadbolt N, Hall W (2016) *A Pragmatic Approach to the Right to Be Forgotten*. Ottawa: CIGI, prepared for the Bildt Global Commission on Internet Governance. Available at: www.cigionline.org/publications/pragmatic-approach-right-be-forgotten

Technological advances in the use of data

Mike Lynch

Dr Mike Lynch OBE FRS FREng DL is founder of Invoke Capital, a large fund that invests in European technologies. He is a member of the Council for Scientific Technology – the Prime Minister's scientific advisory panel – and a UK Business Ambassador. He has founded a number of companies and advised venture capital and private equity groups. He is a member of the advisory board of the Newton Institute and is Deputy Chair of the Foundation for Science and Technology.

SUMMARY

- There have been fundamental changes in the amount and nature of data, and there are now large amounts of unstructured data available that can be used for a variety of purposes.
- Powerful new algorithms can produce insightful results from incomplete data that would have been unusable in the past.
- Machine learning systems that rely on large amounts of data are being developed.
- Ensuring privacy and security of data without undermining the usefulness of the data is challenging.
- Data is a strategic asset and although in some cases it is right to share it openly for societal benefit, we should not shy away from realising its commercial value.

We are witnessing a revolution in the type and amount of data available. Open data sets are a major part of this, but are not the whole story. There are many data sources that will never be open and they too form part of this debate. We are seeing a paradigm shift in the data we collect and, perhaps more importantly, the ways in which we use data.

New ways of using data

Traditionally, data were gathered for a single defined purpose: for example, people's names and addresses would be formally recorded and entered into a structured database created for a specific purpose. Vast amounts of the data being generated now are 'unstructured' – for example, pieces of prose, video and audio recordings – and these do not work in the same structured way. We now have the ability to take data from completely independent sources and bring it all together – what is often called 'data fusion'. This enables us to discover things that could not be found out before.

We also have powerful new algorithms that can mine data, even dirty, incomplete and inaccurate data. In the past, much time and effort was spent in cleaning up data before we could use it. Our goal has now shifted from producing perfect data to producing perfect results from imperfect data.

Perhaps the biggest change at the moment is the advent of machine-learning systems. These learn by using algorithms based on large numbers of examples, which means they need large amounts of data. They are being used to perform a variety of tasks in fields such as law and finance.

Keeping data secure

All of these changes raise issues of security and privacy (which are not the same thing, but are very closely intertwined). Although there are benefits in having access to lots of data, there are also risks.

Few would argue about the benefits of having data on cancer treatment, for example. Yet the price we pay for these benefits is the risk of data breaches. It is not possible to achieve full data security. It is known that 80% of FTSE companies already have significant infiltration into their networks.

Does that mean we should stop collecting data, though? If we had worked on that basis in the airline industry, we would have stopped flying aeroplanes long ago, on the basis that occasionally an aeroplane crashes. While every effort must be made to minimise breaches in data security, we also need to be practical if we want to gain benefits from that data.

The powerful algorithms in use today make it very easy to de-anonymise data and track it back to source.

Keeping data private

The powerful algorithms in use today make it very easy to de-anonymise data and track it back to source. Although there are systems that protect anonymisation, occasionally they are going to fail. This is a difficult problem. Although there is much research being done to find a way of protecting anonymity without undermining the data, the solution is proving elusive.

Privacy, though, is not a single concept but a spectrum. We are more sensitive about some types of private information than others. Moreover, we are seeing changes in the definition of privacy. The advent of social media has meant that younger people have a different view of privacy than their elders. For example, recently I remarked to a young woman, an Oxford graduate, that a photograph of her very drunk at a party had appeared on her social media page. I said to her: "You do realise you can't ever take

Microsoft's machine intelligence chatbot very quickly learned foul-mouthed racist and sexist invective from humans online

this stuff back – once it's out there it has gone forever, you can't pull it back? What if in 20 years' time you're the CEO of a FTSE 100 company?" She replied: "Well, all the other CEOs will have similar photos!"

Ownership of data?

Ownership is another thorny issue. People often feel that data about themselves is something that they own and become upset if they think someone is trying to steal it. However, if they receive something in return for it they are often quite open to parting with it.

An initial response to this question is to assume that people and organisations should own their own data. Yet what if the data have the potential to benefit society? We may give consent for our data to be used, but it can be difficult to know in advance what it might be used for. A company may offer cheaper car insurance to drivers who agree to have a tracking device installed in their car to monitor their driving behaviour. That same tracking device might also provide information about the location of traffic delays, or alert us to a malfunction in the car. This information is not the primary purpose of the tracking device, but could be an added beneficial from it.

Some types of data can have enormous strategic value. Facebook is highly valued by investment analysts for the data it has. Data produced by electronic record-keeping in the NHS, which is being paid for by taxpayers, might be of great value to a commercial company that could use the data to inform development and marketing of its products. However, this company might then charge the taxpayer, through the NHS, for that product, perhaps exorbitantly.

In this type of situation, we need a process to identify strategic data and ensure that the taxpayer is recompensed, for example by offering the product at a reduced cost. We should not shy away from realising the value of our data. After all, commercial organisations are well aware of its value.

The law of unintended consequences

As in most fields, we can always rely on the law of unintended consequences. This was brought home dramatically to Microsoft recently in a publicity exercise that went badly wrong. The company had developed a machine intelligence called a chatbot that was designed to learn how to talk to humans by interacting with them on social media sites.

However, within 24 hours of launching, the chatbot had become outrageously foul-mouthed, pouring forth racist and sexist invective. Microsoft had to issue an apology and withdraw the chatbot.

It is interesting to note that this machine intelligence was simply mimicking what it learned in internet chatrooms. People did not like what they saw in the mirror! Our data can reflect ourselves in ways that we may not be prepared for – or like.

The future

We need to become more sophisticated in the way we think about data. We need to move on from our current focus on data protection and start thinking about controlling the uses to which data is put. We also need to be conscious of the strategic importance of our data and make sure we value it correctly.

I am very optimistic about the future. The UK is strong in this area. The recently founded Alan Turing Institute will build on this to bring together the best people, organisations and technologies in the field of data science. □

We are seeing changes in the definition of privacy. The advent of social media has meant that younger people have a different view of privacy than their elders.

The case against a paradigm shift in the way we use data

David Hand

Professor David Hand OBE FBA is Chief Scientific Adviser at Winton Capital Management, a quantitative investment fund manager, and chairs the board of the UK Administrative Data Research Network. He is also Senior Research Investigator and Emeritus Professor of Mathematics at Imperial College London, where he chairs the Research Board of the Data Science Institute, and is a non-executive director of the UK Statistics Authority.

SUMMARY

- Although there have been advancements in the three dimensions of the data paradigm – data capture, data analysis and data storage – these are incremental developments, not fundamental changes in practice.
- There is a sharper focus on data ownership, but ownership of information is not a new issue.
- The advent of social media may have brought about a paradigm shift in our attitudes toward privacy, but this is a change in human behaviour rather than in the way we manage data.
- Data have always had value, and although this may be increased by advances in the aggregation and re-purposing of data, it is not a new issue, and data are still subject to the old problems of selection bias and poor quality.
- We are seeing dramatic and exciting changes, but they are building on earlier concepts and practices and do not constitute the type of fundamental change that defines a paradigm shift.

A paradigm shift is a fundamental change in the basic concepts and practices of a discipline. Thomas Kuhn, who introduced the phrase in the context of scientific advances, contrasted it with normal science, which he defined as 'scientific work carried out within the context of an existing theory'[1]. So what might we mean by a paradigm shift in the way we access, analyse and protect data?

Dimensions of the data paradigm

The data paradigm can be divided into three fundamental dimensions. The first, and most important, is data capture. It is now effortless to take measurements and collect data. This is true across the board, whether it is a physicist's handheld ruler being replaced by an electronic sensor, our movements across London being tracked through our Oyster cards, or sensors in an aircraft engine that measure hundreds of aspects of fuel consumption and vibration every second.

This automatic, ongoing data capture has stimulated the second dimension in our paradigm: the ability to analyse data as they arrive, in real time. Obvious examples of this are fault detection in aircraft engines and fraud detection in credit card operations. Real value is obtained by having a model to tell us when the data depart from the norm. For example, although analysis of a massive database of customer actions can generate models of typical credit card fraud patterns, it is the ability to match those patterns to transactions as they are made that creates the value. It is no good having a highly accurate credit card fraud detection system that takes three months to make a decision on each transaction.

The third dimension is data storage capacity, which has increased enormously in recent decades, following Moore's Law. However, it is worth noting that although large datasets may be commonplace nowadays, they are certainly not new. The 1910 UK census collected information on 10 questions from 32 million people. Over 20 years ago, Walmart collected data from some 7 billion transactions a year.

These are basic changes, but I would not describe them as a paradigm shift. They really represent continuing, albeit perhaps accelerating, trends. There are also more subtle and challenging higher-level changes, such as the question of data ownership.

A new focus on data ownership

Issues of data ownership are not new, but the advent of modern data capture technologies has made them more critical.

Ownership of something is important because the owner has the right to decide what to do with it: how to use it, who they might permit to use it and, perhaps, whether to sell it. Some data can legitimately be regarded as 'mine' – my age and height, for example. But perhaps other data items have shared ownership. For example, I might share ownership of my salary details with my employer and ownership of my tax records with the HMRC. A school pupil might be regarded as sharing ownership of

Some data can legitimately be regarded as 'mine' – my age and height, for example. But perhaps other data items have shared ownership.

their test results with their school. Does that mean that the school should obtain the pupil's permission before publishing analyses which include the data?

Every time we make a credit card transaction, around 70 items of information are recorded. As well as the value of the transaction, these include the nature of the good or service purchased, the currency, the location in which the transaction took place and the type of machine on which the transaction was carried out. Who owns these data? It is our transaction, but it is the transaction that is being described, not us. On the other hand, if we put all of an individual's credit card transactions together and build a model of how they behave, surely we are now describing that person?

Conversely, if a person's age, which is certainly their data, is used in the calculation of the average age of the population, does this mean that the data about the age of the population partly belong to that person? In general, is the agent who takes the measurement that creates the data its owner, or is the person being measured the owner?

Aggregated data

Questions about the ownership of aggregated data can be even more subtle. For example, in many situations, individual data and aggregate data interact. In choosing medical interventions, in deciding whether a customer is a good risk, in accepting an applicant for a degree course, and in a host of other applications, choices are made by matching data describing the individual to data describing aggregate behaviour. A million past records are used to build a model and a prediction for an individual is then obtained from that model, by matching the individual's data against the model. All of the issues described are old hat – they do not constitute a paradigm shift.

The holders of some of the largest collections of data describing individuals are governments. In this context the term 'administrative data' is often used, although it applies more widely than just to data held by governments. Indeed, the credit card transaction data mentioned above are administrative data in another context.

In Government, administrative data include tax records, education records, records of local authority interactions, criminal justice records as well as other types. In contrast to survey data, administrative data might be described as what people do, not what they say they do. They are generally cheaper to collect than survey data.

Some modern data sources go even further in extracting detailed information from people. The classic example is social media, where people often seem willing to divulge very personal information. This raises the question of whether our notions of privacy are changing. And here, although this change might indeed constitute some sort of paradigm shift, it is a change in human behaviour, not in data or the science or technology of data *per se*.

One suggestion is that people should receive a small payment every time 'their' data are used. But this is hardly a paradigm shift.

Data have always had value

It is not straightforward to put a value on data, or even to identify precisely where that value lies.

Unlike goods and services, data can be sold, or even lost or stolen, while still being kept. With data you really can have your cake and eat it! However, other forms of intellectual property, such as recorded music and written text, have the same sorts of issues, so this probably does not constitute a paradigm shift.

One suggestion is that people should receive a small payment every time 'their' data are used. Perhaps when our data are used in a statistical analysis, for example to construct a credit scorecard, or build an epidemiological model of illness, we should be paid. After all, internet companies such as Google and Facebook make enormous sums of money as a result of data freely given to them. But again, this suggestion is hardly a paradigm shift. Credit scoring agencies spring to mind as a business model which creates (or extracts?) value from data. Their customers are the people who buy (that is, pay for) credit reports about people who want to borrow money, not the people seeking the loans (who give their data freely).

While such questions were less important prior to the advent of massive data capture and storage capabilities, that does not mean they did not exist. They certainly do not represent a paradigm shift.

Re-purposing data

Data can be analysed again and again in many different ways, without in any way using them up. This fact is one of the drivers behind the abundance of start-ups based on the availability of large datasets, with many of them being based on re-purposing data – it may have been collected and analysed with one aim in mind, but then new uses are found. There may be new discoveries within the data, or new discoveries when linking the data to other sets of data, or applied to different problems. This re-purposing is not exactly a paradigm shift, although it is a promising opportunity for social and economic advances.

The data capture revolution and the data storage revolution are certainly posing new problems requiring the development of new analytic tools

We can collect and analyse data more quickly than ever. But faster is not different.

such as online, real-time analyses and software tools for parallel analysis of massive datasets. Once again, though, these issues lie very much within the existing paradigm – not a new one.

Poor quality datasets are nothing new

Quality has always been a key issue in data analysis. Statisticians used to have a saying that 90% of the work lay in cleaning the data, with 10% devoted to real analysis. When I was training to be a statistician, one of the first things I was taught was to familiarise myself with the data, look for peculiarities, sense-check it and so on. Now that is perfectly feasible with a hundred or even a thousand data points, but it is not feasible with a million or a billion, nor is it feasible if the data are arriving every microsecond. The problems are not new, but they are certainly larger.

Although checks may be devised for every possible fault in the data that we know about, we cannot do so for every possible fault there might ever be. This has always been the case, even if the size of the challenge has grown. A particularly pernicious example of the data quality problem is that of selection bias. I have had start-up companies excitedly tell me about their software producing results 'based on analysing the entirety of the data', which they assumed meant that it was not susceptible to sampling error. However, the data they analysed was only about people who had already chosen to become customers and might be wildly misrepresentative of people the company wanted to recruit as customers in future.

Faster is not different

We can collect and analyse data more quickly than ever. The changes are dramatic and exciting. But faster is not different. Bigger is not a step change. Data ownership questions are not new.

My overall conclusion is that we are not seeing a paradigm shift. Advances in data technology do not require us to throw out the old, as a paradigm shift would; rather, they encourage us to build on and extend our existing approaches. ❐

[1] Kuhn D (1962) *The Structure of Scientific Revolutions* Chicago: University of Chicago Press.

An alternative approach to data governance

Baroness O'Neill of Bengarve CH CBE FBA FRS FMedSci joined the panel of speakers for the discussion following the formal presentations and made an initial response. She is a philosopher and crossbench member of the House of Lords. She is well known for her work on ethics and consent. Baroness O'Neill is a Deputy Chair of the Foundation for Science and Technology.

The longstanding EU approach to regulating private data has been based on an attempt to distinguish between personal and non-personal information. In the UK, the *Data Protection Act* 1998, based on an EU directive, governs the processing of personal data. It is focussed on the type of data collected, rather than the use to which it is put. Personal data is defined in law as 'data that relates to a living individual who can be identified', either by the data itself or by other information that is in the possession of, or likely to come into the possession of, the data controller.

This is not the most useful way to think about private data, for a number of reasons. While data such as people's names and addresses that identify them immediately can be removed or hidden, many other sorts of data that may come into the possession of the data controller will enable individuals to be identified.

Moreover, which data individuals regard as personal or private varies according to context. Informed consent is not a robust way of regulating the reuse or re-purposing of datasets. It cannot be given for future uses of data that cannot be anticipated, or which data subjects cannot understand.

Regulating datasets

It is a fundamental mistake to try to regulate by attempting to classify data as personal or non-personal. It is more feasible to regulate the use of datasets, as the new EU Regulation on data protection seeks to do. Regulation can be used to control who may (re)use data and how they may, and may not, use it. This could be more effective in protecting individuals, while at the same time maximising the usefulness of the data to society. The big ethical and legislative question is how ethically robust data governance is to be secured.

There are promising developments in ethically robust data governance, such as the 'safe haven' structures being used in the UK Biobank research programme and in the Scottish Health Informatics Project. However, cases differ and data governance remains a major, unfinished, politically controversial issue. ❐

The debate

Issues raised by the audience included questions on sharing of private data, re-purposing, and the need for more data analysts.

The boundary between shared and private data may depend on whether the social value of sharing outweighs the perceived invasion of individual privacy – for example, using data on the location of 999 calls to access potentially life-saving information. There will always be data that individuals regard as deeply sensitive, for example in the mental health area.

In the future, accountable-computing techniques might be able to ensure that the appropriate conditions of use travelled with the data.

Re-purposing of data could lead to significant new profitable opportunities. The value of data has risen in recent years as data analytics has developed.

Principle asset

Data is the principal asset of many internet-based companies. However, the business model of some internet companies amounts to covert manipulation of spending through advanced internet marketing using consumers' personal information. The public may come to push back against this technology, and resistance to data capture may build.

Aggressive exploitation

An economic downturn could lead companies to exploit data more aggressively to survive. However, the benefits of the digital world are considerable and provided individuals continue to see advantages in social media and online commerce, they will accept the monetisation of their data. Government access will remain more sensitive and citizens would expect to see regulation of access. In both private and public sectors, the best way of countering public resistance is transparency about the uses to which data can be put and the authority required.

Data integrity

Maintaining the integrity of data is a future concern, as the economy and society become increasingly dependent on it to function. Bias can be hard to detect in autonomous decision systems involving machine learning, where the algorithms have been developed using training data that is not representative of the population for whom decisions are being taken.

Pitfalls have already been demonstrated in the interpretation of key sets of data such as crime statistics and property prices, where the information is provided by contributors with vested interests in the results. The public deriving its information from these data need education in the biases that are inevitable in this type of reporting.

The UK will require more data analysts to exploit the opportunities, and this needs to be prioritised by further education. It is essential for the economic health of the UK to have the right skills in the workforce to make the most of the huge potential of open data. □

FURTHER INFORMATION

Competition and Markets Authority Report. Retail Banking Market Investigation: Provisional Decision on Remedies
www.gov.uk/government/uploads/system/uploads/attachment_data/file/523755/retail_banking_market_pdr.pdf

Data Science Ethical Framework launch
www.gov.uk/government/speeches/data-science-ethical-framework-launch-matt-hancock-speech

European Commission. Protection of Personal Data
ec.europa.eu/justice/data-protection/

Open Data Institute. The Open Banking Standard.
theodi.org/open-banking-standard

Open Data Institute. We Need to Strengthen Our Data Infrastructure
theodi.org/data-infrastructure

Royal Academy of Engineering Report. Connecting Data: Driving productivity and Innovation
www.raeng.org.uk/publications/reports/connecting-data-driving-productivity

ROUND-TABLE

A round-table discussion was held before the debate to examine what the Chair, Dr Mike Lynch, described as the transformational role of big data. The opening discussants were Gavin Starks, Chief Executive of the Open Data Institute, and Mike Warriner, Engineering Director of Google UK. The discussion is included in the summary of the day's events on the Foundation's website at **www.foundation.org.uk**.

What is the value to the economy of the financial and insurance sectors, and is the regulatory framework sufficient to protect this value? These questions were debated at a joint meeting of the Foundation and Gresham College held at Lloyd's of London on 6 July 2016.

Financial services are an essential part of modern society

Anne Richards

Anne Richards CVO CBE FRSE is Chief Executive of M&G Investments and an executive director of Prudential plc. Prior to this, she was Global Chief Investment Officer and Head of the EMEA region for Aberdeen Asset Management. Her investment career as a fund manager and analyst has spanned 24 years and several major financial houses. Before moving into investment management, Anne spent six years working as an engineer, including a spell as a research scientist at CERN.

SUMMARY

- Financial services turn the savings of individuals into a giant pool of working capital that powers the economy.
- The financial markets enable people to share what would otherwise be unacceptable levels of risk for individuals.
- The financial sector also transforms short-term savings into long-term investments.
- Elimination of all risk through regulation will also remove rewards and incentives.
- Financial services are a force for good in society rather than ill.

I think it is fair to say that too few people understand the real benefits the finance industry brings to society and the difference it makes to their lives. Banks are much more highly respected in countries where a significant proportion of the population are unbanked or with limited access to the financial system. However, as an industry, we have been exceptionally poor at communicating the value of what we do.

Economic conversion

Financial services offer a mechanism for economic conversion. It turns thousands of scattered, tiny pots of savings into a giant pool of working capital that is put to work for the benefit of all. It also transforms short-term money into long-term investments – again, for the good of all society.

Most people do not connect the huge amounts of money headlined in the media with their own savings. Yet by pooling the savings of people, finance not only creates deep wells of capital for industry, commerce and even government to use for growth, wealth creation and jobs, but it also diversifies risk for savers. The consumer gains and so does the citizen. It should be a win-win affair.

Without this collectivisation of savings, all our lives would be poorer. Fewer houses would be built, fewer roads constructed and many businesses would simply not get off the ground. The Queen recently opened a new children's hospital in Liverpool with 16 state-of-the art operating theatres and the capacity to treat 275,000 children in a year. Part of the finance came from funds run by my own company – with money from our savers.

Finance also helps individuals to spread their risks. Some risks, which might be too much for an individual to bear, can become acceptable if the burden is shared across a wider pool of people.

It is the same with investment. Take the corporate debt market. Companies issue bonds – in other words, borrow money – to fund investment in factories, warehouses, goods or services, which in turn bring choice to customers and create jobs. Now, issuing bonds is an expensive process if a company has to go to a myriad of individuals and borrow small amounts from each of them. As a result, companies set a minimum contribution level to keep the cost down, but this is beyond the pocket of most individuals.

Through a mutual fund, which is just a pool of individual investors, people with as little as a few hundred pounds can have the opportunity to lend a small amount not just to one blue chip company, but hundreds of them. The individuals benefit through the interest earned on their holdings and through the fact that their exposure to the failure of any one company is limited. The company benefits, because it has access to funding that might otherwise not be there. Society as a whole benefits, too, through the creation of jobs and greater customer choice.

Recent and rapid improvements in communications and computing power are making possible a huge range of new financial services, such as Apple Pay, Bitcoin, crowdfunding, contactless and peer-to-peer lending. Who knows which of these will stand the test of time and prove to have been socially useful? But some certainly will.

Maturity transformation

Another vital aspect of financial services is known in financial jargon as 'maturity transformation'. In addition to transforming large numbers of small sums into larger pools which can spread risk and be used to invest in, for example, companies, loans or infrastructure, the finance sector transforms short-term money into long-term money.

By depositing money in a bank, the saver is actually lending it money. The bank does not lock it in a vault and guard it until the saver wants it back: it would have to charge rather a lot for services such as honouring cheques, carrying out bank transfers and setting up direct debits or standing orders. In fact, it does not charge very much (sometimes nothing) for most of these services. Instead, it lends the money out to other people who need to borrow it in order to buy a house, a car or fund a small business.

Now, the money deposited with a bank can normally be withdrawn on demand. However, banks know it is very unlikely that everyone will ask for this at the same time. They rely on that assumption when they lend your money out to other people, in the form of a 25-year mortgage. They have transformed instant access deposits into 25 year loans: that is maturity transformation.

The ability to balance the needs of both saver and borrower – collectively – has enabled Britain to become a nation of home owners rather than renters. It is a wonderful piece of prestidigitation – or conjuring to you and me.

The underlying risk

However, there is a risk at the heart of this. If people ever lose confidence in their ability to get their money back when they want it, there will be a run on the bank. This is exactly what happened to Northern Rock in the great financial crisis and is every regulator's greatest fear.

If there is profit to be had, then the financial services industry will find new and different ways to take advantage, sometimes without regard to the long-term consequences. The mortgage market is no different. It evolved from relying purely on deposits to something called financial securitisation. This is where individual mortgages are pooled into a single pot, repackaged into smaller pieces and then sold on to individual investors.

This had disastrous consequences in the USA. As the author Michael Lewis commented with black humour, in this particular instance banks had turned long-term money into short-term losses.

Financial regulation

That seems to be an appropriate point to consider financial regulation. To those unfamiliar with the financial world, it must seem that the regulators are forever bolting the door after the profiteering horse has bolted. A few scalps here for insider trading, a few prison sentences there for egregious fraud. Yet still the man and woman in the street sense that there is something wholly inequitable about the financial system.

Finance does not work in a vacuum – it has to operate within broader moral, ethical, legal and ideological parameters set by society. There is a tension between those who support *laissez faire* principles of unrestricted capitalism and those who back state-sponsored, centralised control. As one approach waxes, the other wanes and vice versa.

Typically, freedoms are allowed until someone takes them too far. Then the pendulum swings the other way. In the heady 1990s, stolid building societies were allowed to jettison their mutual status and embrace the capital markets. Then it all turned out horribly wrong. When the credit crunch came in 2007, the first victims were former building societies. Northern Rock, once a local institution which claimed to lend to one in three homes in North East England, was the first to crumple.

And the regulators' response? Once the panic was over and the most vulnerable members of the banking community had been rescued either by stronger institutions or the state, they moved to ensure that this would never happen again through a raft of regulations and increased capital requirements.

For example, RBS had an equity Tier 1 capital ratio – a measure of financial strength – of only 2% at the time it acquired ABN Amro. Today this is 13% on a tighter definition of risk-weighted assets.

The history of finance is littered with examples of this dance: easing, followed by tightening, followed by easing again, and so on.

Another example is the *Glass Steagall Act* of 1933 in the USA, which separated investment and commercial banking and sought to limit the powers of commercial banks to engage in 'risky' stock market activities with depositors' money. It is now seen as one of the contributory causes of the financial crisis of 2007.

Risk in the system

The temptation for all regulators, with one eye on both the consumer and the citizen, is to legislate to remove most risk from the system. And they do this by being as prescriptive as possible about the rules. I have no idea how big the rule book of the Financial Conduct Authority is today, but I would bet that it is many times

The temptation for all regulators, with one eye on both the consumer and the citizen, is to legislate to remove most risk from the system. But eliminating risk removes the possibility of rewards and the incentive to provide capital for economic growth.

bigger than those of its regulatory predecessors.

Natural though the reflex to legislate might be, there is an obvious danger in any attempt to eradicate risk from the financial system. Eliminating risk removes the possibility of rewards and the incentive to provide capital for economic growth, wealth creation and jobs. As with many things in life, it is a matter of balance – between profitable risk which benefits all and protection of individuals from the unscrupulous.

In conclusion

The financial services industry is, I believe, more a force for good than ill. It plays a vital role in the wider economy as a conduit for people's savings to business, Government and other organisations in need of capital for investment. These in turn create jobs and then the people who hold those jobs have savings which can be funnelled into other businesses. A virtuous circle, if you will. □

The future of the insurance market

John Nelson

John Nelson was appointed Chairman of Lloyd's of London in 2011. He has had a long career in banking – he worked for Kleinwort Benson until 1986, before joining Lazard. There he ran the corporate finance division, becoming Vice Chairman in 1990. Later he was at Credit Suisse First Boston Europe, where he served as Chairman. He is a Trustee of the National Gallery and chairs its Development Committee. He is also a member of the UK Prime Minister's Business Advisory Group.

Lloyd's of London of course is not an insurance company – it is the world's only insurance market – and we are the global hub for specialist risks from all over the world that are too complex or unusual for other insurers to take on. We insure commercial risks such as reputational damage, cyber insurance and property damage.

Lloyd's has a long history of innovation. It provided the first insurance cover for cars, planes and satellites. Today, we cover everything from earthquakes and tsunamis, to new and emerging risks such as cyberattack, terrorism and a whole range of special lines like drones.

Our market consists of over 80 syndicates, each one like a separate insurance company. We are a fully brokered market. Brokers approach syndicates with business from all around the world. The magnitude of these risks is often so large that no single insurer is able to accept it on their own, so the syndicates join together to share risks.

Should syndicates not be able to pay for any reason, they are backed by the Lloyd's Central Fund which is there to cover any unpaid claims.

While we operate in more than 200 territories worldwide, much of the business at Lloyd's is still conducted face-to-face. Brokers have direct access to decision-makers, which enables fast and responsive solutions.

In recent years we have also established important underwriting centres in China, Dubai and Singapore, and we have a network of offices around the world.

It is a unique model that has prospered for more than 300 years.

SUMMARY

- The London insurance market makes a major contribution to UK GDP.
- Insurance and reinsurance plays a vital part in UK and international economies.
- The London insurance market is under pressure from several directions.
- To flourish, London needs continued access to the best talent from around the world.
- Regulation must strike a balance in ensuring a robust, efficient industry and an environment in which innovative business development can flourish.

Lloyd's and London

We are one part of the wider London insurance market, a sector that makes an important contribution to the UK's GDP and is a key driver of economic growth. What is the value of finance and insurance to the UK economy? The London insurance market controls about $80 billion of annual premiums. It employs almost 50,000 people, and generates more than 20% of the City of London's GDP.

That is the direct impact. Indirectly, insurance and reinsurance protects economies, communities and businesses from threats as business models change and new economies emerge.

When catastrophes strike, insurers provide capital in the form of claims payments that help businesses, governments and communities get back on their feet much more quickly and efficiently than if they had to rely on public money.

Offshore reinsurance plays a substantial role in diversifying risk out of country. Obvious examples of this are the most recent earthquakes in New Zealand and Chile, which were mainly reinsured offshore. So insurance and reinsurance play a key role, not just in the UK economy but in the wider global economy.

Pressure on the market

The insurance market is being buffeted by the cold macro-economic and geopolitical winds we have all experienced over the past few years. And there are a number of sources of this pressure.

The most recent is, of course, the UK's decision to leave the EU. This is unnerving investors and adding uncertainty to an already challenged market. Until we formally exit Europe, it is business as usual at Lloyd's but we will have to see what deal is struck before we can fully assess the implications.

The consequences for the City of London could be substantial – for Lloyd's, less so. Only around 4% of our revenues will be directly affected by Brexit, but there could be collateral damage to London's reputation as an insurance centre.

Then there is the long term fallout from the 2008 banking crisis. Low interest rates are substantially reducing investment returns on capital and are driving investors, seeking new types of return, into the insurance market. This additional capital is lowering premium rates and putting insurers' bottom lines under severe pressure.

The broader economic picture is changing too. There is a shift in wealth from west to east. Companies are increasingly setting up their headquarters in new and emerging markets. This changes the type of risks they are servicing and changes where insurers' customers are based.

The nature of risk

The nature of risk is also changing. Lloyd's City Risk Index, published in 2015, quantified for the first time the impact on the GDP of 301 cities from 18 threats. It found that $4.6 trillion of GDP is at risk over the next decade from these threats. While natural threats like earthquakes and flooding still pose the largest risk to GDP, an increasing amount – $2.1 trillion – is associated with man-made threats, like cyber-attack, market crashes and oil price shocks.

Technology is disrupting traditional insurance business models, allowing new tech-savvy companies to sell directly to customers using big data to fine-tune products to customers' needs.

The extent to which the London insurance market is under pressure was spelled out in the 2014 Boston Consulting Group's report, *London Matters*. It concluded that:

- London does not have a strong position in emerging markets;
- It is losing share in reinsurance;
- Customers have a preference for buying insurance in their local market, putting 30-40% of London premiums at risk of being written locally;
- Its expense ratios are higher than its peers.

Lloyd's introduced its Vision 2025 strategy five years ago precisely to address these issues, and I am pleased to say the execution of this strategy is progressing well.

The other challenge the report highlights is the comparatively high regulatory burden that could further render London less competitive.

Reforming regulation

Brexit, for all its downsides, could be a good opportunity to thoroughly review domestic regulation as it applies not just to financial services but also to the other sectors that drive the engine of UK plc, such as technology, science, and research and development.

What will make the UK an even more attractive place to do business as we move away from the agreements with Europe? In my view, there are two key requirements.

First is access to a wide talent pool. We have in the London market a cluster of expertise producing a responsive set of businesses. To sustain this, we must have access to the best talent from around the world. Although a politically difficult issue at the moment, relatively free movement of people is fundamental to our industry. We will have to wait and see to what extent the principle of free movement is retained or discarded in the Brexit negotiations, but we will be pushing the Government hard to retain our current access to talent.

The second requirement is to minimise unnecessary bureaucracy – excessive red tape stifles business growth. One advantage of being in the EU is the passporting rights that businesses enjoy, which allow them to trade in all European countries through a single licence. This is extremely efficient but a right we may lose after Brexit.

The alternatives are likely to be more costly, time-consuming and bureaucratic, which is why Lloyd's will be lobbying, with other industries, to retain passporting rights.

In the meantime, the Government needs to look at the domestic regulatory set-up and reduce red tape where possible.

The implementation of a regulatory regime that strikes the right balance between prudential oversight and the creation of a competitive market is vital. Much has been written regarding the

While natural threats like earthquakes and flooding still pose the largest risk to GDP, an increasing amount – $2.1 trillion – is associated with man-made threats, like cyber-attack, market crashes and oil price shocks.

regulatory burden imposed on the City of London, and insurance in particular, by Europe. But let us not forget that UK regulators can and do impose their own burdens.

It is important that the UK, and London in particular, retains the strong prudential regulation that has been a major attraction – but without the excessive bureaucracy and complexity that is stifling business and innovation.

With Brexit, it is even more important that we address this question energetically to make London and the UK a more attractive place to do business. And this work should apply across all financial services regulation.

Protectionism

Another emerging reality is an increasing trend towards protectionism – sometimes as a result of local regulatory regimes. Lloyd's is experiencing this trend at first hand as we seek new licences and defend existing ones in markets around the world.

Our mission in the insurance industry is to promote the idea of more global standardisation in regulation, in part to encourage the liberalisation of insurance that will improve the sustainability and growth of national economies.

There is a worrying trend to translate or copy-and-paste banking regulations across to insurance – perhaps a consequence of the global financial crisis. In fact, the insurance sector came through that crisis extremely robustly.

So the challenge for Government will be to regulate in a way that strikes the right balance between ensuring a robust, efficient industry and the creation of an environment in which innovative business development can flourish.

We currently face a very challenging competitive environment, but if we can achieve these two objectives of talent and regulation, then I am optimistic the UK insurance industry will continue to flourish and play its crucial role in domestic, European and international economies.

The question we should try to answer is what steps can we take in the UK to liberalise further our financial services and insurance markets, while maintaining effective prudential supervision. □

Sectors still in need of reform

John Kay

Professor John Kay CBE FRSE FBA is one of Britain's leading economists. His interests focus on the relationships between economics and business. His career has spanned academic work and think tanks, business schools, company directorships, consultancies and investment companies. He chaired the Review of UK Equity Markets and Long-Term Decision-Making, which reported to the Secretary of State for Business, Innovation and Skills in July 2012. He is a visiting Professor of Economics at the London School of Economics and a Fellow of St John's College, Oxford.

I first walked into Lloyd's in 1989 when it was facing up to a crisis. I remember listening to someone talking about the growth in its business during the 1980s and I asked how much of that growth 'walked in through the front door', as distinct from being generated within the market itself.

I had to reframe this question several times before I got an answer. What was happening in Lloyd's in the 1980s was a microcosm of what happens across the financial services sector right up to today: it has come more and more to trade with itself.

The Lloyd's insurance market is and always has been predominantly a reinsurance market. If you can sell reinsurance you could also sell reinsurance of reinsurance and perhaps even reinsurance of reinsurance of reinsurance, and so on.

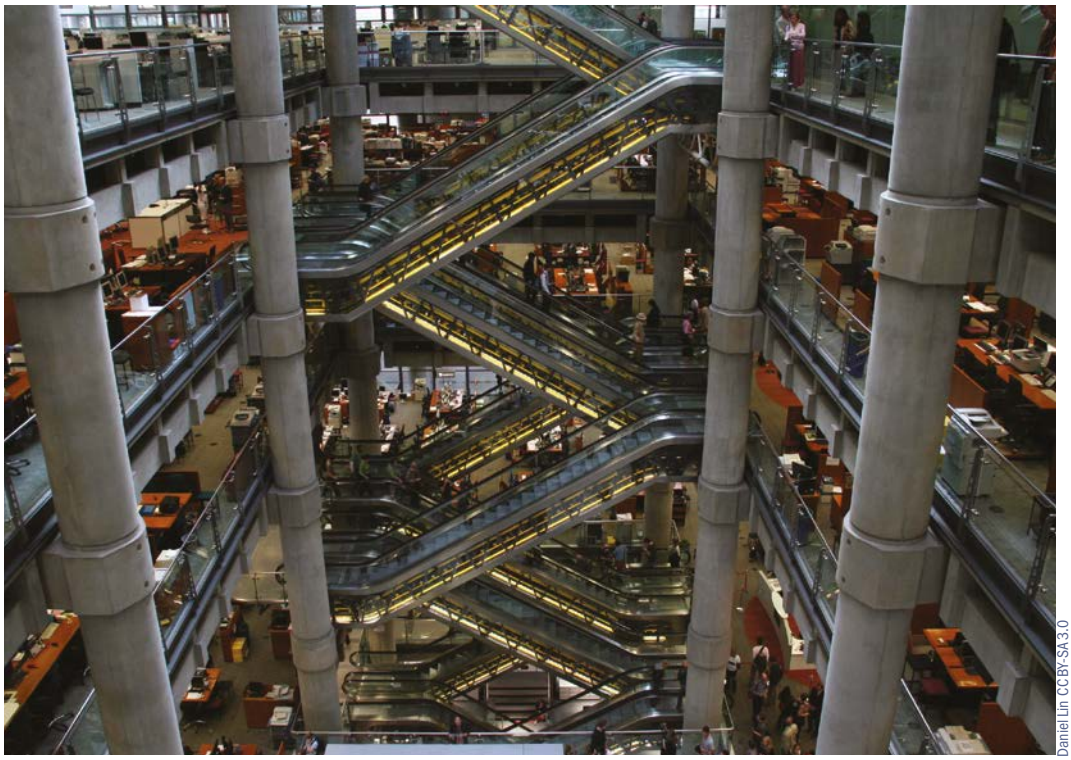
All of this generated (apparently) profitable business. However, it became increasingly difficult – indeed impossible – to drill down and discover the nature of underlying risk exposures. In Lloyd's, the people taking on the risks knew nothing except that people had modelled these kind of contracts and discovered that historically you virtually never had to pay out.

SUMMARY

- The financial services industry grows primarily by intra-sector trading.
- General techniques of national income accounting do not work when applied to financial services.
- The kind of regulation we have had to date has not been effective.
- Today's risk management approaches are driven by their roots in both mutualisation and gambling.
- Structural change and an ethical culture of personal and corporate responsibility is needed.

Catastrophes

Then in the late 1980s there was a series of catastrophes. Many will remember Piper Alpha, an oil rig in the North Sea which caught fire, killing 167 people. It was then one of the largest marine insurance claims ever made. Much of that was reinsured with Lloyd's. An original claim of about US $1 billion turned into total claims of ten times that amount as the reinsurance contracts triggered the reinsurance of reinsurance, etc. The



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What was happening in Lloyd's in the 1980s was a microcosm of what happens across the financial services sector right up to today: it has come more and more to trade with itself.

risks, far from being spread among people who understood them, became concentrated on people who understood nothing about it at all.

Looking at what was happening in credit markets around the world from 2003 to 2008, I was asking myself the question: "Where are the equivalents of the English gentlemen who naively signed up to these contracts and ended up having to sell the furniture from their stately homes to meet the Lloyd's losses?" What I did not understand at the time was the extent to which the people ultimately taking these risks were based in the large financial conglomerates.

Over the past 40 years now, the sector has grown very rapidly but largely through trading with itself. Global trade in foreign exchange today is 100 times the volume of the underlying volume of growth in goods and services. Many people are still under the illusion that banks take our savings and turn them into loans to businesses – actually, loans to non-financial businesses account for less than 3% of the total assets of UK banks today.

The total nominal volume of derivative exposures today totals about $600 trillion, which is a mind-blowing number as it is two-to-three times the value of all the assets in the world. Much of the growth of financial services is in this 'intra sector trade'.

It has been known since the 1940s that general techniques of national income accounting do not work when applied to financial services. To see that, simply note that one of the largest increases ever seen in the GDP share of financial services occurred between 2008 and 2009: that does not reflect a common sense view of what was going on over that period.

What is the purpose?

We really need to ask what the financial services sector is for. While it may be an essential part of the economy, it does not follow that the more financial services an economy has, the better and more effective it is. This sector should, in my view, do four things.

Payments

The core utility of finance is to provide a payments system. This is how we receive our wages and salaries, pay our bills and through which businesses can transact with each other. This is actually what most people in financial services do – they are not masters of the universe with telephone number salaries, they are people doing rather mundane clerical jobs in banks and insurance companies.

But of all the areas of finance, this is the one currently going through the most disruptive innovation. I think that in 20 years' time, our grandchildren will be astonished that we once needed bits of folded paper in our pockets in order to buy a cup of coffee.

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What is needed is a quite different regulatory philosophy – one that is based essentially on issues of industry structure and incentives.

Wealth management

By wealth management, I do not mean the rather expensive services provided to so-called 'high net worth' individuals, but something broader: the process by which people are able to access education when they are young, buy houses, provide for retirement and pass wealth on to subsequent generations if they want to do so.

Capital allocation and risk mitigation

The third and fourth of these activities are the ones wholesale financial markets are mainly concerned with: capital allocation and risk mitigation. I want to look in more detail at risk mitigation.

A 1991 book by French economist Michel Albert called *Capitalisme Contre Capitalisme* explored two origins of the world insurance industry. Swiss villagers in the 17th and 18th centuries would gather together to mutualise the risks they faced. To simplify a bit, they would agree that if one of their cows died, the village would club together to buy a new one. That kind of 'mutualisation' of societal risk was established in southern Germany and Switzerland: today organisations like Munich Re and Swiss Re are still global players in this particular market.

Then of course, there is Lloyd's Coffee House at the turn of the 18th century. English gentlemen would gather together to while away the time, spend their money and gamble. They would gamble on more or less anything: the health of the King, the results of battles that the English Army and Navy were fighting around the world, the weather, the state of the tides, etc. That transformed, gradually, into an institution because merchants realised that they could come to this place and lay off some of the risks associated with the growing mercantile development of the British economy.

So trading in risks has two basic underlying motivations – one is the gambling motive which was the beginning of Lloyd's Coffee House and the other is the mutualisation process which went on in the Swiss villages. These continue to be part of the business of risk transfer and risk management in the world today.

The 1930s Glass Steagall Act separated retail from investment banking. We now need to separate the distinct functions of investment banking.

Regulation

When discussing these issues with a general audience, this is usually the point when people say: "Well, of course what we need is more regulation of the financial sector" and if it is a financial audience, the call is for "less red tape and regulation".

I am closer to the 'less regulation' side, because I think that regulation has been a large part of the problem, rather than part of the solution. Indeed, the story of the credit default swap which played such a prominent role in the 2008 crisis is a good example, because it came into being to exploit differences in the regulatory treatment of banks on the one hand and insurance companies on the other. Banks must provide regulatory capital by reference to the amount of the loan, while insurance companies need to provide capital by reference to the amount of expected loss.

Take a large loan to an organisation like Exxon Mobil, for example (which was indeed one of the first credit default swaps). If that transaction is treated essentially as an insurance policy rather than a banking risk, much less regulatory capital need be put behind it. That is exactly what the credit default swap was set up to do.

Of course, as so often happens with the financial services sector, by 2006 the market had exploded, the original purpose had been lost sight of and it had simply come to serve other quite different purposes. But the credit default swap came into being as an instrument of regulatory arbitrage and a great deal of the complexity of the financial system has, essentially, that origin.

Regulatory failure

So, in my view, the kind of regulation we have had has been an extensive and intrusive failure. What is needed is a quite different regulatory philosophy – one that is based essentially on issues of industry structure and issues of industry personal and corporate incentives.

The *Glass Steagall Act* of the 1930s separated retail from investment banking. In my view we need to go much further and separate the distinct functions of investment banking.

The modern bank engages typically in securities issuance, in advisory work for corporations, it makes markets, it takes positions on its own account and it provides asset management services to external clients. Each of these aspects is potentially in conflict with all the others, both in terms of the interests of the ultimate customers and in terms of the culture required to be effective.

So we need to effect structural change in the industry and we also need to create an ethical culture of personal and corporate responsibility. ❐

The debate

Issues raised by the audience included the interconnected nature of the sector, the role of regulation and the need for innovation.

Public perception of the finance industry is adversely impacted by the fact that banks are seen to be too big or too important to fail and are, in the last resort, bailed out by the taxpayer. The problem is less that banks are too big to fail – Lehman Brothers was the classic example – but that the system is so interconnected that failure has multiple effects which are difficult to contain.

Arguably, a better response would be to follow the example of other sectors, such as the electricity supply industry, where resilience is built into the structure, with the stress on modularity, not inter-connection. The finance industry might also have something to learn from the insurance industry in terms of improved, more sophisticated methods of risk assessment.

Excessive reliance on regulation to deal with financial stability might drive consolidation. While not inherently bad, there is a risk that in consolidating to bigger and bigger entities smaller ones become disadvantaged.

Mutualisation and co-operatives are currently being favoured as an operating model, but is it right to emphasise only one model. That model has its own challenges. Plurality is often a good thing.

Focus on transparency

Could a greater focus on transparency counter the increasing complexity of modern financial instruments and systems? Or would more self-regulation by the industries, subject to suitable safeguards for the public, be better than the current framework of regulation which had in essence been drawn up for a different sector?

There is an evident difficulty in trying to regulate moral and ethical behaviour. But it is an unavoidable issue. Codification may be helpful; but, finally, the answer must lie in getting the right leadership, setting a zero-tolerance approach to inappropriate behaviour (including strengthening the diversity of teams) and a more systematic approach to ensuring that all teams, at all levels, employed 'devil's advocates' to challenge 'group think'.

Ignorance should no longer be regarded as a defence for Boards and senior executives; and legal incentives that encourage individuals not to know about the actions of their colleagues should be addressed. The issue of excessive levels of remuneration for salaried employees whose own capital is not at risk must also be tackled. Public incomprehension and dissatisfaction with excessive remuneration has been reflected in the Brexit vote. It is an issue the industry has to address.

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The failure of Lehman Brothers affected the whole financial system.

The industry should invest in innovation. There are cases where innovation in the UK has only proceeded on the back of the support of US investors, who seem to put a higher premium on subject expertise and investment potential than UK venture capitalists.

The UK also needs to develop stronger public infrastructure to support small businesses at the very earliest stages of innovation development. □

FURTHER INFORMATION

Financial services: contribution to the UK economy, House of Commons Library, 2015. www.parliament.uk/briefing-papers/sn06193.pdf

Global underinsurance report:
www.lloyds.com/news-and-insight/risk-insight/library/understanding-risk/global-underinsurance-report

Gresham College www.gresham.ac.uk

Prudential Regulation Authority, Bank of England
www.bankofengland.co.uk/pra

Research Councils (RCUK) www.rcuk.ac.uk

How should universities and Research Councils proactively respond to gender bias in success rates for grant applications? To discuss this challenge, the Foundation for Science and Technology held a round-table discussion at the University of Leicester on 22 June 2016.

Bridging the research gender gap

Professor Paul Boyle CBE FRSE FBA, President and Vice-Chancellor of the University of Leicester, opened the discussion by noting that his university considers the elimination of bias in all fields of research, appointment and promotion as a high priority. A paper published in *Nature*[1], which he had co-authored with colleagues, showed that there are areas in research funding where bias persists. In the paper they made 10 suggestions for tackling this challenge (see box).

Professor Henrietta O'Connor, Deputy Head of College of Social Science, Arts and Humanities and Professor of Sociology at the University of Leicester observed that the *Nature* paper demonstrated that women were more fairly treated in social sciences, but that there was still some way to go before gender equality was assured in Science, Technology, Engineering and Mathematics (STEM).

The *Nature* paper had created discussion and other articles have since appeared reflecting on issues in STEM subjects. HR departments are becoming more aware of these too. Still, all-male panels and panels composed of those with identical mindsets remain. There is still a gender pay gap.

So is the perceived improvement merely superficial or does it represent a real trend which will follow the pattern of the social sciences?

The social sciences

In the 1950s, gender discrimination in the social sciences was rife, but it was gradually realised that more staff were needed and that many of these academics would be women. Those who took up appointments did not like what they found and wanted to research along feminist lines. It was the pioneering work of women in the 1960s and 1970s which had changed social sciences. Would there be a similar change in STEM?

Linda Holliday, Director of Capacity and Skills Development at the Medical Research Council described how the MRC and the other Research Councils are publishing material about applications and success rates. A 2015 analysis of applications over four years to the MRC showed that there was still a bias, although the difference in success rates (1.5%) was narrowing[2]. However, this was aggregated data and it is important to look at success rates across different programmes.

She noted that while the gender balance at PhD level is equal, the proportion of women in senior posts is significantly lower. Only 19% of programme holders are women and they form only 26% of Principal Investigators (PIs). Should the Research Councils rely on universities to rectify gender imbalance themselves or should funding procedures have a role?

New research has shown that barriers are created by time limits on research; lack of flexibility as clinical researchers move between universities and the NHS (affecting pay); and the perception that women ask for smaller grants and so move more slowly up the pay band. The Research Councils are aware of the importance of considering the life patterns of applicants and the need to avoid creating unnecessary barriers. Linda Holliday's concern over the 10 points listed in the *Nature* paper was whether they ignored longer term funding issues.

The Research Councils themselves now have an action plan which should decrease barriers and enable progress in this area[3].

The debate

Following the presentations, a more general discussion ensued. One issue raised was the very difficult problem of dealing with bias through references. Do funders see a personal reference from a woman differently from one received from a man?

The name at the head of any research application is usually the PI who, being the most senior, is very often a man. More applications are now headed by Co-Principal Investigators (CoPIs), which may give a woman's name as well, but there is limited data on gender split here. Questions are sometimes asked about the rank of the researcher: is he/she a professor? Perhaps there should be, throughout the application process, a double blind system operating so that the gender of applicants' reviewers and referees is hidden.

Do funders see a personal reference from a woman differently from one received from a man?

Career paths

Many women reach the rank of senior lecturer and then either stop applying for promotion or remain stuck in their grade. The Research

Councils should pay particular attention to this group. Their failure to move on might be because of life circumstances, lack of stimulus, fear of failure or hierarchical prejudice, but undoubtedly there is talent here which should be accessed.

As fewer professors are women, there are fewer applications for grants from women, which means that women are getting less money. It is important that funders look at the economic results of decisions. The gap between European awards for men and women was also discussed.

A University of Leicester Physics and Astronomy Department survey showed that nearly all respondents who had gone for promotion had self-initiated that process. A self-initiating system may be less favourable to women than a mentoring and coaching approach.

Stereotyping

Stereotyping is an issue. There should be training within the research community (as well as in panels and Councils) on how to avoid this. However, there is a risk that training easily turns into a box-ticking exercise, which in itself can become yet another hurdle to promotion.

There is a danger in assuming that the problem lies with the way women respond to bias. If gender bias is to be overcome, it must be through a change of attitude in both sexes and the process of cultural change will be a long one. It is not enough for women to put themselves forward if there remains resistance to their progress. Here, the whole of the research community needs to be engaged. The Athena SWAN programme should be revised as it is not always proving effective in changing attitudes towards women.

Quality and quantity

While the publication of success rate statistics and other aggregated data is valuable, an emphasis on quantity should not overlook the importance of quality. How to measure quality is difficult, but if excellence is to be found and real innovation achieved, it should remain a priority.

The discussion focussed on Higher Education, but the attitudes engendered in both sexes are planted much earlier. Much greater attention should be given to the attitudes of teachers in schools and the aspirations they expect to see in pupils of different genders. Indeed, the problem goes even further back, to a macho culture which trivialises women and establishes an unconscious bias which can affect men of all classes at all stages of their careers.

The 10 action points proposed in the *Nature* paper are valuable indicators of ways to lessen gender bias. Should there be a division between universities and funders, though? The two must work together and it may not be easy to decide whether funders should exercise greater pressure on universities, or whether the impetus should come from the institutions themselves.

In the end, though, it is pointless to commit to "ambitious expectations for gender performance" without adequate funding support. In addition, the "targets for minimum gender representation on funding panels" do not take account of the pressures on women at different stages of their lives. But there was strong support amongst the participants for more radical action on this subject, particularly in regard to pay. □

The Foundation is grateful to Sir Geoffrey Chipperfield KCB for his help in preparing this summary.

PROPOSED ACTION POINTS

Funding agencies

1. Commit to ambitious expectations for gender performance that link to eligibility for receiving awards, following the lead of the National Institutes for Health Research.
2. Introduce targets for minimum gender representation on funding panels.
3. Train selection panels on gender-equality issues, including unconscious bias.
4. Submit data annually to independent scrutiny of gender differences in applications, success rates and award sizes.
5. Publish figures to allow cross-agency/cross-national comparison by discipline.

Universities

6. Publish gender breakdowns in key areas including appointments, promotions and rewards in a consistent way, allowing for cross-institution comparison.
7. Embed gender-equality issues in work practice. Become beacons of good practice for public-sector and private employers.
8. Support women's career progression through the ongoing development of promotion criteria that focus on quality rather than quantity.
9. Engage men in championing gender equality. Commit to the principles and uptake of shared parental leave.
10. Celebrate women's achievements equally in a public way.

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[3] RCUK – Action Plan for Equality, Diversity and Inclusion www.rcuk.ac.uk/documents/documents/actionplan2016-pdf

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?
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Professor Sir Nigel Shadbolt FREng, Chairman and Co-Founder, The Open Data Institute
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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
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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]

Using science to authenticate, verify or assure the identity of people and things
2 March 2016

Sir Mark Walport FRS FMedSci, Government Chief Scientific Adviser
Dr Derek Craston, Government Chemist and Managing Director of Science and Innovation at LGC
Professor Dame Sue Black DBE FRSE, Professor of Anatomy and Forensic Anthropology at the University of Dundee

Bringing science to the heart of government: the Nurse Review of the Research Councils
12 January 2016

Sir Paul Nurse FRS FMedSci, Chair, the Nurse Review of the Research Councils, and Director, The Francis Crick Institute
Professor Phil Nelson FREng, Chair, RCUK Executive Group and Chief Executive, Engineering and Physical Sciences Research Council
Gareth Davies, Director General, Business and Science, Department for Business, Innovation and Skills
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Professor Jonathan Haskel, Professor of Economics, Imperial College Business School
Tony Harper, Head of Research and Advanced Systems Engineering, Jaguar Land Rover

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4 November 2015

The Lord Teverson, Chair, House of Lords Select Committee on the Arctic, House of Lords
Jane Rumble, Head, Polar Regions Department, Foreign and Commonwealth Office
Professor Dame Julia Slingo DBE FRS, Chief Scientist, Met Office

The Accelerated Access Review for the Department of Health (the Taylor Review)
26 October 2015

Sir Hugh Taylor KCB, Chair, Accelerated Access Review, Department of Health
Sir Leszek Borysiewicz FRS FRCP FMedSci FLSW, Vice-Chancellor, University of Cambridge

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22 October 2015

Phil Boswell MP, MP for Coatbridge, Chryston & Bellshill, House of Commons
Iain Conn FREng FRSE, Chief Executive, Centrica plc
Gary Haywood, Chief Executive Officer, INEOS Shale
Professor Rebecca Lunn FRSE FREng, Head of Department, Civil and Environmental Engineering, Professor of Engineering Geosciences, University of Strathclyde
Ben Ritchie, Senior Investment Manager, Pan-European Equities, Aberdeen Asset Management [Panellist]

The Dowling Review of Business-University Research Collaborations
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Professor Dame Ann Dowling DBE FRS FREng, President, Royal Academy of Engineering
Sir Peter Gregson FREng, Vice-Chancellor and Chief Executive, Cranfield University
Eric Hawthorn, Managing Director, Radio Design Ltd
Professor Jeremy Watson CBE FREng FIET, Professor of Engineering Systems, University College London [Panellist]

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8 July 2015

Sir David King ScD, FRS, HonFREng, The Foreign Secretary's Special Representative for Climate Change, Foreign and Commonwealth Office
Dr Bernie Bulkin, Director, Ludgate Investments Ltd
Ed Heartney, Environment, Science, Technology and Health Counsellor, Embassy of the United States of America in London
Sir Colin Humphreys FRS FREng, Department of Materials Science, University of Cambridge [Panellist]

The business of the environment: can the tension be resolved between resource extraction and environmental protection?
24 June 2015

Professor Duncan Wingham, Chief Executive, Natural Environment Research Council
Professor Simon Pollard, Pro-Vice-Chancellor, School of Energy, Environment and Agrifood, Cranfield University
The Lord Oxburgh KBE FRS, House of Lords
Professor Jane E Francis, Director, British Antarctic Survey [Panellist]

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