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THE FOUNDATION FOR SCIENCE AND TECHNOLOGY

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Digital twin projects win funds to model environmental processes

Five projects harnessing the potential of digital twinning technology to transform environmental science will share a total of £2.8 million in funding delivered by the Natural Environment Research Council (NERC), in partnership with the Met Office, as part of the Twinning Capability for the Natural Environment (TWINE) programme.

The digital twin pilot projects will demonstrate how research using Earth observation data and emerging digital twinning technologies can transform environmental science across priority areas including climate change, biodiversity and ecosystems, and natural hazards.

A digital twin is a dynamic virtual copy of a physical asset, process, system or environment that looks like and behaves in real time identically to its real-world partner. Actions and events can be modelled with unprecedented accuracy, offering the ability to experiment in a non-live environment of the real world.

The five projects are led by scientists at Plymouth Marine Laboratory, National Oceanography Centre, University of Cambridge, University of Hull and University of Plymouth. They will develop digital twins in:

- coastal ocean ecosystems for assimilation to marine system models
- ocean glider observations for ocean models which underpin weather forecasts
- the operational flights of a research aircraft
- water-related hazard forecasting in Hull and East Riding of Yorkshire
- wave overtopping to produce a warning tool for wave hazards.

The projects will last a maximum of 15 months.

World breaches 1.5˚C warming target in 2023

January 2024 was the warmest January in the ERA5 atmospheric reanalysis of the data record going back to 1940. The global surface air temperature was 13.14°C, which is 0.70°C above the 1991-2020 average for January and 0.12°C above the previous warmest January, in 2020. Taking into account the average of the last twelve months, the global mean temperature was the highest on record at 0.64°C above the 1991-2020 average and 1.52°C above the 1850-1900 pre-industrial average.

Samantha Burgess, Deputy Director of the Copernicus Climate Change Service (C3S) said: "2024 starts with another record-breaking month – not only is it the warmest January on record but we have also just experienced a 12-month period with a mean global average temperature more than 1.5°C above the pre-industrial reference period. Rapid reductions in greenhouse gas emissions are the only way to stop global temperatures increasing."

The average global sea surface temperature (SST) for January outside the polar regions reached 20.97°C, the highest recorded for January and the second highest monthly temperature in the ERA5 dataset for any month, only 0.01°C below the highest, reached in August 2023.

https://climate.copernicus.eu/surface-air-temperature-january-2024

European weather centre for Reading

Plans for a new European Centre for Medium-Range Weather Forecasts (ECMWF) headquarters on Reading University's Whiteknights campus have been approved. It will house 300 scientists in a state-of-the-art, sustainably-designed facility. The move from ECMWF's current home to a plot next to the University's Department of Meteorology will create one of the world's largest clusters of weather and climate scientists in the world.

Construction is expected to begin later this year, with the project due to complete in autumn 2026.

Setting out a roadmap for nuclear power

The Government has published its roadmap for what it describes as 'the biggest expansion of nuclear power for 70 years'. The Civil Nuclear Roadmap will, says the Government, give industry certainty of the future direction of the UK's ambitious nuclear programme.

The roadmap sets out how the UK will increase generation of nuclear supply by up to 4 times to 24 gigawatts (GW) by 2050 – enough to provide a quarter of the UK's expected electricity needs.

The plans include next steps for exploring a gigawatt-scale power plant as big as Sizewell in Suffolk or Hinkley in Somerset, which will themselves be capable of powering 6 million homes each.

In addition, the Government commits to invest up to £300 million in UK production of the fuel required to power high-tech new nuclear reactors, known as HALEU, currently only commercially produced in Russia. This builds on the ambition to return uranium conversion to the Springfields nuclear fuel site near Preston.

An additional £10 million will be provided to develop the skills and sites needed to produce other advanced nuclear fuels in the UK, helping to secure long term domestic nuclear fuel supply and support the UK's allies.

The roadmap includes a government ambition to secure 3–7GW worth of investment decisions every five years from 2030 to 2044 on new nuclear projects.

www.gov.uk/government/publications/civil-nuclear-roadmap-to-2050

Government pumps money into decarbonising industry

Over £190 million is being made available to help industry in the transition to net zero, reducing emissions as they switch to cleaner, cheaper energy. The Government opened a new phase of the Industrial Energy Transformation Fund in January for £185 million to help companies transform their operations to run on cleaner, more secure energy – supporting measures such as replacing inefficient equipment, installing electric furnaces and switching to hydrogen. The funding is designed to ensure businesses are supported in the transition to net zero in a sustainable and cost-effective way, securing green industrial jobs for the future.

Sectors including manufacturing and recycling – and for the first time controlled environment horticulture, industrial laundries and textile renting facilities – will be among those eligible for apply for this new support, as part of wider government efforts to meet the UK's net zero targets.

Twelve winning projects from the Local Industrial Decarbonisation Plan competition have also been announced. These will each benefit from a share of up to £6 million to develop plans for a low carbon future. The projects bring together local partners to develop plans to cut manufacturing emissions.

This will be targeted at projects outside of the UK's major industrial areas – from a Yorkshire pet food manufacturer to a Poole ferry operator. Companies in dispersed locations away from industrial heartlands account for 55% of the country's industrial emissions.

Lords' warning on light and noise pollution

The House of Lords Select Committee on Science and Technology has published a report on artificial light and noise and their impacts on human health. It concludes that environmental noise and light remain neglected pollutants, are poorly understood and poorly regulated.

Both noise and light pollution impact negatively on human health through disrupting sleep and circadian rhythms. Epidemiological evidence suggests that noise pollution causes annoyance and increases the risk of stroke and heart disease. Research from the UK Health Security Agency suggests the equivalent of 130,000 healthy life years are lost from noise pollution each year in Britain. This has significant impacts on the economy: sleep disturbance is estimated to cost the UK economy £34 billion a year, according to RAND Europe, and noise and light pollution are contributing factors.

The Committee is concerned that the Government's 25 Year Environment Plan only briefly mentions the issue, with no specific targets for reduction, and that there is seemingly little impetus from government to address them. Light and noise pollution can all too often fall through the cracks between departments, and between central government policy and local government implementation.

https://committees.parliament.uk/committee/193/science-and-technology-committee-lords/news/196536/light-and-noise-pollution-are-neglected-pollutants-in-need-of-renewed-focus

New facility sheds light on polar organisms

The British Antarctic Survey (BAS) will build a new science facility at its UK Cambridge headquarters, enabling scientists to understand how organisms that live in cold polar environments evolved and the impact of environmental change on these special ecosystems.

The new Controlled Environment Facility will include a polar marine aquarium (run at –2°C to 0°C), and three environmental experimental rooms (operating at –5°C to 30°C) with precision instruments combined with deep-frozen storage. It will be the only combined low temperature biological storage and experimental facility in the UK and one of three globally.

Polar ecosystems have adapted over many millions of years to very cold temperatures and extremes of light – 24 hours of sunlight in summer and 24 hours of darkness in winter. Huge amounts of undiscovered biodiversity (it is estimated that there are 20,000 species in the ocean around Antarctica alone), are under severe threat from climate change.

Loss of biodiversity in the polar regions has many consequences beyond ecosystem sustainability and conservation. For example, research at the new facility will enable scientists to identify novel proteins and new compounds for potential applications in medicine, biotechnology, and other industries.

DSIT publishes map of innovation activity

The Department for Science Innovation and Technology (DSIT) has published an Innovation Clusters Map. It aims to provide a comprehensive picture of firm-level innovation activity in the UK and is designed to help policymakers, investors and many more besides to better understand, engage with and invest in the UK's ecosystem.

From space in Scotland to net zero in the North East, and from advanced manufacturing in the Midlands to life sciences in the South, the UK is home to some of the world's cutting-edge clusters. Enabling these clusters to reach their potential is essential to delivering on the Government's target of making the UK the most innovative economy in the world.

Launching the Map, Science Secretary Michelle Donelan said it would play a vital role in supporting three of the Department's goals for clusters:

- Increase private investment in innovation clusters significantly, building on substantial public investment, and anchored in clusters' unique strengths.
- Ensure clusters can expertly communicate their investible propositions to investors and have access to the right support to take these to fruition.
- Ensure people across the UK benefit from the innovation-led economy, by creating high-skilled jobs and prosperity across its innovation clusters.

www.gov.uk/guidance/find-uk-innovation-clusters

GUEST EDITORIAL

Drones are becoming more and more common in today's world. But while more opportunities to enhance our lives are becoming daily more apparent, their increased availability brings risks to be managed as well.

Drone technologies – a potential game-changer?

Iain Gray

Professor Sir Iain Gray is the Director of Aerospace at Cranfield University. Prior to this, Iain held roles as Chief Executive of InnovateUK and Managing Director of Airbus UK. In 2014, he was awarded a CBE for services to innovation and in 2023 he was awarded the honour of Knight Batchelor for services to the aerospace industry. Iain is a Chartered Engineer, a Fellow of the Royal Academy of Engineering; a Fellow of the Royal Society of Edinburgh and a Fellow of the Royal Aeronautical Society.

On 1 March 2024, a new UK Defence Drone Strategy was launched by the Government, unifying the approach across the British Army, Royal Navy and Royal Air Force, integrated by UK Strategic Command. The strategy announcement is supported by some £4.5 billion of investment and will work closely with industry. The mainstream public events calendar for 2024 includes regular drone light shows that engage the public in telling amazing stories. We also regularly hear of drones being used to deliver medical supplies cost effectively to those living in remote areas, including the transportation of organs to save lives.

It all seems a long way from the newspaper headlines back in December 2018 when hundreds of flights were cancelled following reports of drone sightings which closed the runway at Gatwick for nearly two days. No evidence of drones was ever found but the incident caused massive media speculation, creating confusion and concerns across business and the public. Were drones a benefit or a threat to society? It had a significant impact on the widespread adoption of drones across the UK.

Transformational benefits

Five years on and the world has changed. The Covid crisis saw extensive use of drones supporting our blue-light services and introducing essential drone delivery arrangements. The Ukraine crisis over the past two years has stimulated technology development of not just drone technology itself but also the management of drones in manned airspace. This has changed key aspects of modern warfare. These and other applications have highlighted the transformational benefits that can come with extensive use of drones.

I have had the privilege to be involved with the Government-sponsored Drone Industry Action Group (DIAG) for a number of years and have seen this transformation take shape – but there is still much to be done. DIAG was established in 2016 as a collaborative forum between Government and industry to 'inform, support and shape the business environment' needed for successful commercialisation opportunities for drones in the UK.

There has been much progress since DIAG was first formed although it has been slower than first envisaged. In the summer of 2022, the Department of Business, Energy and Industrial Strategy (BEIS and now the Department for Business and Trade) put forward a Drones Ambition Statement for the UK. This outlined how Government would work together across Departments and business to achieve a vision for commercial drones which would make them commonplace across the country by 2030. The Statement built on the market assessment work done by PWC in their 'Skies without Limits' report. In this, they estimated that drones could be worth £45 billion to the UK economy by 2030 – bringing benefits to wider society through delivering new capabilities, boosting productivity, contributing to the net zero carbon targets with reduced emissions and reducing risk to life. This would be done sharing airspace safely and equitably with other users.

The Government, led now by the Department of Transport, has established a Future of Flight Industry Group. Co-chaired by Government and industry, this will collaborate on the development and delivery of a Future Flight Plan to maximise the benefits from the new drone and Uncrewed Aerial System (UAS) technologies through to 2027. This pathway includes objectives to have the UK's first commercial drone delivery operational by 2025 and envisages drones used routinely in Beyond Visual Line Of Sight (BVLOS) operations within health, emergency services and policing by 2027.

The Government (through UKRI and InnovateUK) and industry has funded drone and UAS innovation projects in a multi-year Future of Flight Grand Challenge. Innovate UK has provided £125 million investment backed by £175 million from industry. The Challenge has delivered real progress to advance future flight in the UK and to demonstrate, among other objectives, the safe integration and operation of drones.

In addition, the Challenge has brought in social science research and has addressed public perceptions as well as questions of trust and social desirability. Among the many funded projects have been work with Royal Mail and NHS Kernow to provide residents in Cornwall and on the Isles of Scilly with drone deliveries of mail and medical supplies. Others have transformed the way we survey critical infrastructure such as powerlines and railway lines.

There are still barriers to be overcome - mostly regulatory, legal, insurance and social acceptance concerns rather than technology-related issues. PWC issued a report some 18 months ago entitled 'Building Trust in Drones' to assess how business attitudes towards drones have changed and recommending what else needs to be done. The report concludes there is little doubting the positive benefits of drones and it highlights some great application opportunities, for example, for road traffic management, asset inspection and the relaying of images and data to support search and rescue.

However, though the survey work done by PWC showed increased positivity towards drones, it concluded that only 43% of respondents thought industry was using drones effectively and many people were still unsure about them and waiting to be convinced.

At Cranfield University we have been involved in Uncrewed Aerial Vehicle (UAV) research and development for over 30 years. It is one of the few universities in the world with its own airport, its own runway, ownership of its own airspace navigation service provider (ANSP), its own aircraft and its own pilots. The facilities and capabilities are brought together under the Cranfield Global Research Airport – very much a UK national asset.

It carries out world-leading research on autonomous systems, communications and airspace management, alongside the regulatory and commercial framework of running an operational airport. This presents great opportunities for research and development in tandem with the practicalities of doing things in a regulated airspace environment – a small microcosm of the wider UK airspace and urban environment. The National Drone Innovation Gateway has also been established at Cranfield, led by Cranfield University, Neuron Innovations and Ebeni with the aim of supporting innovators in the UK drone ecosystem.

There are excellent examples of new start-up businesses which have used the facilities and expertise available at Cranfield to build their business – two great examples are Herotech8 and Iona.

Herotech8 has developed the concept of providing 'drone-in-a-box' technology to support round-the-clock automated drone operations. It has great applications for aerial inspection and monitoring capabilities without the need for onsite pilots or teams. One striking example from Herotech8 is their partnership with Magnox and the decommissioning of nuclear sites. The process is highly complex but a dedicated drone system removes the need for manual inspection and surveillance work and so reduces cost, risk, time and resource, all of which mean operations on site are completed safely and more efficiently.

The remote access drone station also allows for inspection and surveillance tasks to be completed without the need for individuals to be on site at all and can be quickly executed without ever requiring a pilot to set foot on the facility. The benefits of unmanned facility inspection and surveillance in hostile environments are significant.

Iona is another drone start-up company based out of Cranfield. They have developed a very efficient robotic network for low cost and sustainable deliveries in rural areas. During the Covid crisis, Iona worked with the Argyll & Bute Health and Social Care Partnership to get testing kits and results to isolated communities as quickly as possible. During a three-month initiative, medical deliveries that traditionally took 24-36 hours took just 15 minutes. The concept has now been extended to other projects.

Cranfield Airport is also part of the CAA innovation sandbox, promoting uses in a carefully managed and regulated environment. The sandbox project at Cranfield is seeking to fly in the vicinity of Cranfield Airport and Milton Keynes, enabling crewed and uncrewed aircraft to co-exist in a safe and efficient operating environment.

On a wider recognition front, an organisation called Airwards was established with the aim of creating awareness, building trust and changing perspectives through awards and story-telling. Previous winners have come from around the world and the awards have recognised technology, operations, supporting services and industry applications as well as identifying the innovators who have made great progress.

The progress since that Gatwick moment in 2018 has been significant and industry has done much to highlight the potential benefits to society while being mindful of the potential risk to UK security evident in the increasing use of this technology in war. So, the work to realise the full UK economic and social benefit continues. The prize is worth chasing and we all have a part to play in ensuring the UK can realise these benefits, and that the vision and ambition of drone commercialisation by 2030 is fully materialised. □

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Survey work by PWC showed increased positivity towards drones, but many people were still unsure about them and waiting to be convinced.

CONTEXT

On 7 September 2023, the UK and the EU concluded an agreement for the UK to participate in the Horizon Europe and Copernicus programmes as an associate member. The UK was a very active member of previous EU research programmes before Brexit, but various political factors delayed the UK associating to Horizon Europe. The new agreement opens the way for UK researchers to build on and expand research collaboration with partners in other European countries. However, the extended period of uncertainty about the UK's participation meant that there is much that now needs to be done – by the UK Government, funding agencies, universities, industry, and by our partners in the EU – to ensure that the UK maximises the opportunities that Horizon Europe provides.

The Foundation for Science and Technology held an event on 6 December 2023 to discuss these issues. The speakers were: George Freeman MP, Former Minister for Science, Research and Innovation; Professor Maria Leptin, President, European Research Council; Professor Christopher Smith, Executive Chair of AHRC and UKRI International Champion; and Professor Mary Ryan, Vice Provost (Research and Enterprise), Imperial College London.

A video recording, presentation slides and speaker audio from the event are available on the FST website: **www.foundation.org.uk/Events/2023/Horizon-Europe-%E2%80%93-making-UK-participation-a-success**

Maximising the opportunities for science and innovation

George Freeman

George Freeman MP was Minister of State in the Department for Science, Innovation and Technology (DSIT) from its creation in February until November 2023, after being appointed Minister of State in the Department for Business, Energy and Industrial Strategy (BEIS) from October 2022. He had previously been a Minister in BEIS and Minister of State for the Future of Transport at the Department for Transport. He was the first UK Minister for Life Science + Agritech in the Coalition Government.

SUMMARY

- Association with Horizon was always part of the original Brexit deal. UK exclusion was not the UK's choice
- While Horizon presents the UK with a great opportunity, we should not forget other potential research collaborations globally with key nations like Israel, Switzerland and Japan
- There needs to be a strong UK Fellowship programme to attract talent to this country
- The industrial landscape of the UK is quite different from that of other European countries
- We must help our high-growth sectors to fully engage with the opportunities.

The agreement we negotiated to rejoin Horizon prompts a more general question: if we are going to be a global force, a global science and technology superpower, then what is the right balance between our focus on Europe and on the rest of the world? More immediately, we also need to use this opportunity of association not just to get back to where we were, but make the most of the new 108% cap to expand UK Horizon participation.

When the Brexit deal was being negotiated, it was an absolute red line for me and those of us involved that we were leaving the political union, but not the scientific, cultural, defence or security unions. In my view, if we were going to leave the political union, we had to redouble our commitment to the other institutions. So we negotiated continued engagement in Horizon, Copernicus and Euratom.

When I came back into Government in the autumn of 2021, I was appalled to find that Horizon had been weaponised in reaction to the difficulties over the implementation of the Brexit deal in Northern Ireland.

While we needed to repair the relationship with our European partners on that issue, it seemed to me that we had to do everything we could to get back into Horizon – but also to prepare for the possibility that we could not. So I was surprised to find there was no Plan B when I arrived. That was clearly needed – and I referred to it as 'Plan B' in order to remind everyone that Plan A was to get back into Horizon as quickly as possible.

Yet that moment in time also afforded an opportunity to ask some big questions about the key steps required to become a global leader in deploying science, research, technology and innovation. Not least was the issue of the balance of funding in the total R&D budget across Government of £52 billion over three years. Horizon membership would account for approximately £7 billion but expenditure beyond Europe was only about £0.5 billion. Was that the right ratio for a country looking to do more globally?

That is where the central thrust of the Pioneer

plan arose. I wanted to examine what could be done with the Horizon money if it were redeployed on a more global basis. This was partly because it was necessary at the time, but also in order to open up a conversation about some of the things we might and could do, in addition to Horizon.

The Horizon programme has three pillars: first, the talent pillar, the European Research Council (ERC); second, the global and industrial elements; and third, innovation. Pillar 1 is completely essential. There are over 120 ERC professors working in the UK and these are some of our top researchers. When the UK was unable to associate to Horizon, they were faced with having to relocate to Europe. That would have been a disaster. To address that, it seemed to me vital that the UK needed to match that programme with a big Fellowship programme of its own.

In addition, we could use the Pioneer opportunity to address structural weaknesses in our early-, mid- and late-stage Fellowship ecosystem. I met a brilliant, 29-year old biomedical scientist from Oxford at the Max Planck Institute. She had just been awarded 10-year funding for herself and a postdoc, together with a technician and a discretionary budget, and the choice of all the Max Planck Institutes. When I asked her if she had always wanted to move to Germany, she told me she never wanted to move to Germany, but the offer was one she could not refuse.

That is why we really need to think about: a much stronger UK Fellowship offer. The Treasury likes three-year funding, but if we are to attract and retain top talent, fellowships need to be longer or we will lose out to our competitors.

When I examined Pillar 2, it was striking that the UK global and industrial sector is structured very differently from that of France or Germany. There was Rolls Royce and then hundreds of small companies. In France and Germany, there are perhaps 50-100 big engineering businesses, for whom Horizon is a core funding stream.

The UK should perform better in Pillar 3, being an innovation-focussed economy. Yet it was striking that in Pillar 3 we have many small SMEs, but few commercial companies growing at scale. The reason for this is that funding is structured as an academic process with lots of form-filling. As such, it is not really designed for small companies. So we were not performing particularly well there either.

Pioneer was designed to address these pillars, being structured to attract money – or leverage co-investment – into different sectors and industries such as agritech, clean tech, space, fusion or robotics.

Parts of the Pioneer prospectus remain relevant to the Nurse, Tickell and Grant reviews aimed at making our research ecosystem more globally competitive. China's research budget is $260 billion and America's $300 billion a year: as we are committing £20 billion, this needs to have maximum efficiency and impact.

Pioneer was designed to help us do that, while also helping to deepen international collaborations in Europe and beyond. So while negotiations on Horizon were continuing, I went to the key nations that pack a punch in R&D: Switzerland, Israel, Japan. These are countries that are not in the Washington, Beijing, or Brussels blocs, but need to develop deep collaborations with other major economies. We were welcomed with open arms and I was able to negotiate major strategic framework agreements. These provided frameworks that we could replicate, which we did with Canada. It would be a huge mistake not to pursue them. I believe we could have launched Pioneer early in 2022 but Treasury was not prepared to sign off on the programme as quickly as we wished.

We have now successfully concluded an agreement on Horizon and that is partly because of our allies and friends across Europe. In addition, Ursula von der Leyen, the President of the Commission, and the Prime Minister have a very strong working relationship.

Opportunity

The new deal means that we can now get back up to 108% of our contribution, i.e. more than we put in. That is a huge opportunity for the UK which we must seize.

With Horizon re-association, we can now focus on the core business of making our system more competitive. Then, we must realise the huge opportunity we now have. We should make sure that all our high-growth sectors are fully engaged in the programme – clean tech, agritech, space, fusion, quantum engineering, biology, etc.

We need to involve our investor community in this programme. If applying for funding is too academic and complicated, then that has to be addressed. That is why Government has agreed to set up a unit – supported by some big corporates and university experts – to help companies access this money. The opportunity is not just to regain the position we had but to achieve even more.

In due course I hope future Governments will both renew and deepen our collaborations with EU and Horizon partners while also deepening our global collaborations with nations like Japan, Israel, Switzerland, India, Canada and ASEAN.

To be a global science superpower we need to be a major global science and technology player, as well as a strong European partner. □

With Horizon re-association, we can now focus on the core business of making our system more competitive.

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The benefits of competition and collaboration

Maria Leptin

MICHAEL WODAK, MEDIZIN FOTO KÖLN

Professor Maria Leptin has been the President of the European Research Council (ERC) since November 2021 and chairs the ERC's governing body, the ERC Scientific Council. She is a biologist best known for her work on the mechanisms that allow a developing body to take on its correct shape. She is an elected member of EMBO, the Academia Europaea and the German National Academy of Sciences (Leopoldina). She is an Honorary Fellow of the Academy of Medical Sciences, a Foreign Member of the Royal Society and an international member of the US National Academy of Sciences.

SUMMARY

- Having the UK participate in the ERC brings clear benefit for the European Framework Programme
- The creation of the ERC aimed to raise the level of science through competition
- The collaborative nature of Horizon allows researchers to build better and larger networks
- Work is already beginning on Framework Programme 10
- The ERC will be seeking an increase in funding for FP10 in order to support more scientific projects.

It is very good to have the UK back in the Horizon programme. The Scientific Council of the ERC has always believed that the association of the UK to Horizon Europe was important from a range of perspectives. UK colleagues have played an important part of the ERC's calls from the very beginning. Having the UK participate in the ERC brings clear benefit for the entire European Framework Programme in terms of competition, prestige, and in the ability to fund cutting edge research.

Participation is about competition at the very highest level. A researcher from an EU member state winning an ERC grant in competition with researchers from across the community has achieved this in a very competitive and high-level playing field. With the addition of UK researchers, that pushes everyone to raise our game and to come up with the very best ideas (we hope that Switzerland will also shortly be joining the programme).

Raising the level

It is a similar situation for UK researchers who can now compete with EU colleagues. The level is simply not the same when competing solely at a national level. This is, of course, intentional. Framework Programme funding is only a thin sliver of overall EU funding on research and development but one of the main aims of those who conceived the ERC was precisely to raise the level of science through competition, challenging the very best to develop and hone new ideas.

So there is benefit for both sides. For the UK, though, there is further direct benefit. That comes from the collaborative nature of the Framework Programme. Being able to choose partners from the UK means for EU researchers access to better and larger networks. There is a higher chance of finding groups of colleagues and of achieving the aims of specific projects. It is the same for our colleagues in the UK, who can now develop joint projects across Europe.

The association of UK is clearly a win-win on both sides scientifically. And this feeling is shared across the entire European scientific community. We on our side never wavered in our support for UK association. There have been campaigns like Stick to Science as well as direct lobbying. So, welcome back, you have been missed!

The future

In Brussels, we are already starting work on the next EU Framework Programme, FP 10. The European Research Council itself has given the entire EU Framework Programme a dimension that it did not have before 2007, alongside their existing top-down elements, and the EU will look to build on the success that we have seen in this regard.

We hope to reach agreement on strengthening the ERC in the next Framework Programme. We have seen amazing creativity displayed within ERC-funded projects. The talent of Europe's best researchers has been seen at its best when they have been given the freedom to define their own paths, follow their own ideas and pursue their own thoughts with no strings attached.

The guarantee of freedom to follow one's own ideas is what has driven this success in many different fields across technology and innovation. ERC researchers have made breakthroughs in critical technologies like Artificial Intelligence. This was not invented only in 2022 when ChatGPT was released, but has been worked on by ERC-funded scientists and others for a long time. Quantum technologies are another example.

We believe that it is necessary to significantly increase spending on Research and Innovation at the EU level in the next spending period from 2028-34, when we of course hope that we will continue to have the UK as members.

Despite the excellent quality of projects funded by the ERC, it is a sad fact that many equally outstanding proposals have to remain unfunded. We simply do not have the budget to fund everything that is judged as excellent and worth funding by our panels. In addition, the size of ERC grants has not changed since 2009. They have remained the same because if we were to increase the amounts, we would have to reduce the number of awards. That has of course been eroding the value and the prestige of ERC grants, so we really need to do something about that.

It will also be vital to protect the ERC's independence, running our own calls, managing our own grants and maintaining our own mechanisms and processes. So we will call upon the European Commission and its partners to strengthen the ERC's independence and autonomy under Framework Programme 10 – and we will ask for support from the European scientific community, including that of the UK, in pursuit of that goal. We will also request additional funding to safeguard the ERC's position as Europe's pre-eminent frontier research funder. □

DOI: 10.53289/KLIB7895

Building on our existing success

Christopher Smith

SUMMARY

- The UK is already a leader in international science
- Association with Horizon Europe is part of a wider international engagement
- International collaboration makes science better and more effective
- The UKRI Guarantee has enabled UK participation in Horizon projects in advance of association through agreement with ERC
- Domestic research strength and international collaboration will be key to continued UK success.

The UK is already an exceptionally powerful international science player in its own right. Association to Horizon Europe will be an important part of our continuing international engagement. UKRI is the largest public funder of research and innovation in the UK, covering all sectors and disciplines, including innovation. It will have a key role in enabling and coordinating UK participation in Horizon. UKRI's five year strategy, *Transforming Tomorrow Together*, has brought the Research Councils and their independent missions into a single body which has a capacity to operate in ways not dissimilar from the unified vision of Horizon Europe.

The UKRI strategy encompasses a number of strategic themes, which again are comparable with some of the Horizon programme's mission areas. These allow us to concentrate on ways in which we can fund interdisciplinarity and the breaking down of silos between disciplines.

International collaboration is so important because it makes science better. Field-Weighted Citation Impact (FWCI) shows that when we collaborate, then our research is more widely read, more widely used and has greater impact. Key UK strategies set out in *Global Britain in a Competitive Age, the Integrated Review of Security, Defence, Development and Foreign Policy* demonstrate that we do this not out of pure altruism but because it makes our science and our research ecosystem better.

Internationalism is part of the UKRI brand and mission. We have investigator-led international collaboration, as well as dedicated international funding to address gaps and opportunities. The new International Science Partnerships Fund was constructed in part to make sure that our global ambitions were sustained while discussions about association with Horizon continued. It remains an important strategic investment in the context of our scientific relationship with Europe and the rest of the world.

UKRI has a number of overseas offices, including the UK Research Office (UKRO) in Brussels which will be supporting participation. There are also very strong UKRI research facilities across the world, in Antarctica and the Arctic Circle, The Gambia and Uganda, for instance, as well as major infrastructure investments and research ships. Without such an extensive ecosystem, we would not be able to forge the ongoing collaborations that will allow leading-edge science to take place.

Since 2018, UKRI-funded researchers have

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Research requires well-built infrastructure and skilled support staff.

SHUTTERSTOCK/JENSON

collaborated with 181 countries, involving research grants worth £2.3 billion in total. Some 33% of our funding is international, with over 6,000 collaborating organisations overseas, and £900 million is already committed in 2023-24 to our international partnerships. We have retained – and will continue to build – our international capacity.

The UK has in place a Guarantee to smooth the transition into association with Horizon Europe. That Guarantee was a critical arrangement agreed with ERC and delivered by UKRI to cover UK participation in projects prior to association. All calls in Horizon's Work Programme 24 and onwards are covered by the association agreement. Those in Work Programme 21, 22 and 23 are covered – as far as UK participation is concerned – by the Guarantee.

Maximise engagement

In order to maximise UK engagement in Horizon Europe, UKRI's Brussels presence via the UK Research Office (UKRO) will have a leading role in supporting organisations and helping them understand what opportunities are available. That is not just to assist universities but also, critically, businesses. With regard to innovation, the UK national contact points and Innovate UK are also working to incentivise businesses: the mechanisms are not quite the same as for universities.

The Guarantee has, critically, ensured that there has been continuing involvement through which grants have been assessed by Horizon Europe but funded by UKRI. As of 31 December 2023, we have awarded almost 2,900 grants worth over £1.5 billion to UK-based researchers and innovators. We did not stop being part of Europe and we did not stop doing excellent research.

It is important we continue to support and foster success in future years. Equally, when Government legitimately asks for evidence of the effect of participation and the resulting successes, we must not just count the number of applications. The critical statistic will be the excellence of the research that is carried out. There is no value in a large number of bad applications, there is only value in successful applications.

The reason we can be confident that UK research and innovation will bounce back to the level of engagement – and more – that we had with previous programmes is that through the intervening period we have maintained our mechanisms for international collaboration. These include: policies on international co-investigators and visiting researchers; reciprocal agreements with, for instance, Norway and Switzerland; lead agency agreements; joint thematic calls; partnership building mechanisms; fellowships; and also multilateral policy engagement.

It is also important to bear in mind that association with Horizon is not purely about Europe: it is a partnership with other countries outside Europe that also participate in this framework. Our multilateral policy engagement continues with the Global Research Council, the OECD Global Science Forum and Science Europe.

The success of the UK has depended on the strength of the UK domestic capacity and the strength of its broad international collaboration. Through the period of uncertainty, we collectively maintained those international collaborations and our domestic strength. For us to be successful in the future we must continue to use a strong domestic ecosystem to support stable and meaningful international collaboration. □

Association with Horizon is not purely about Europe – it is a partnership with other countries.

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The future, both in and beyond Horizon Europe

SUMMARY

- The association agreement covers more than science and technology – arts, humanities and creative industries also benefit
- Universities like Imperial act globally which is why international collaboration is so important
- Horizon Europe is the world's largest multilateral research programme
- International partners create a multiplier effect for research funding
- Collaboration has continued throughout the hiatus caused by lack of association.

Professor Mary Ryan CBE, Vice-Provost for Research and Enterprise at Imperial College London also addressed the meeting. She pointed out that while we often use the shorthand of 'European science' and 'British science', the association agreement is about so much more than just science and technology. It includes the humanities, the arts and the creative industries, which are really well supported by European programmes. Those sectors had been concerned they would get squeezed out of the conversations that were taking place. Taking an holistic view of what research is – and how all the different pillars fit together – was critical.

Collaborative approach

She argued that the collaborative approach to research that has been made possible by Horizon is really vital for the future health of the UK science and research base, but also for our national security and prosperity. Imperial College and most UK universities operate globally: sometimes that is not fully recognised. European partners are essential to what universities like Imperial do.

Professor Ryan recalled that she had been a member of a working group for Plan B. As soon as those meetings went in the diary, sometimes at the last minute, everybody dropped everything else to take part. That was a measure of how important they were. Nobody wanted to stop calling it Plan B, because there was a plan A that all were holding onto.

She added that the thinking that went into Pioneer served as a useful stress test on how critical this partnership was. What else could be done with similar levels of funding? So it was a really important exercise, one that she thought should be done more often, testing and validating assumptions.

The Horizon Europe programme is the world's largest multilateral research programme. America and China have large programmes but the European one is the biggest. It gives access to networks, flows of ideas, talent and funding at a scale that is globally significant.

It also creates a multiplier effect for UK research. For example, in Horizon 2020, Imperial took part in projects that totalled over €2 billion in value. The direct funding that came to Imperial was multiplied 27 times through partnerships with 16 different countries. That collaboration gave access to data, infrastructure, knowledge and talent from all those different regions. This multiplier effect is critical to UK success and UK excellence. It is driving thought leadership.

Being part of the European programme is key to maintaining excellence on the world stage. Association to Horizon is also the bedrock of the UK's ability to become a science superpower. This is an area which can drive prosperity.

While working for association, UK universities did not just sit back. Like others, Imperial continued competing and was successful in over 170 proposals, bringing nearly €100 million in

IMPERIAL COLLEGE LONDON

in Horizon 2020, Imperial took part in projects worth more than €2bn.

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As part of its international collaborative efforts, Imperial has launched an international research centre with CNRS in Paris.

funding to the university. Importantly, there was no noticeable change in success rates. There had been a concern that applications might be judged differently from those of people from other countries, other institutions, yet there was no evidence of that. UK institutions were still seen as part of the European research community.

Imperial also doubled down on its European bilateral engagements, not just as an insurance policy, but as a restatement of commitment and intent. It launched an international research centre with CNRS (the Centre National de la Recherche Scientifique in Paris). CNRS covers essentially the whole of French science and this collaboration provides a further platform for Horizon engagement.

The Horizon association agreement is in fact a good outcome for the UK, Professor Ryan argued. It is now able to lead projects and has access to European Research Council (ERC) funding. However, Horizon Europe has a limited timeframe. It is important to look forward to the next iteration. First, how can the UK expand its engagement further? How does UK thought-leadership feed into the development of the next framework? And how, indeed, can the UK play a part in those conversations without a commitment to be continually engaged?

As the ERC looks towards the next framework programme, its continuing independence is one of the elements it wants to protect. From a UK perspective, this is important: these multilateral programmes are inherently independent of the short term demands of national politics. That independence helps to maintain the excellence and integrity of the scheme.

In this country, there is both the talent and the will to move forward. There is a well-funded and respected research base which can step into and lead these programmes. UKRI is at the heart of that, along with the academies and also the fellowship programmes that are critical to attracting people. The UK needs both to attract talent and grow its own

Network building

In Imperial, there are early career researchers who, due to the hiatus in Horizon participation – have not yet had the chance to build the European networks that more senior colleagues have developed. They need help through the creation of engagement programmes and fellowship programmes.

Professor Ryan noted that over the past 10 years, academics from Imperial have co-authored papers with people in 192 countries. Of the papers written with the US, 60% also have a European co-author. It is not a matter of doing separate European and American collaborations: that is not how science works. Working out how to connect the European programmes more fully with broader international partnerships will be a key challenge moving forward. □

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The debate

Following the formal presentations, the speakers joined a panel to respond to questions from the audience on topics including: rekindling existing networks; support for younger researchers; other funding sources; and industry's part in the programme.

While there may have been a small dip in the number of UK applications for European grants, that can be remedied fairly quickly. It is important both for UK academics to understand the opportunities now realisable through Horizon and for European colleagues to once again seek to engage UK partners in their projects. The networks did not disappear during UK absence from the programme and they provide the framework to re-establish those collaborations. The research sector did a very good job of keeping the flames of collaboration and engagement alive.

There is no doubt that the delay in association has meant that there is a group of younger researchers coming through who have not had the ability to be fully engaged in these kinds of joint projects. This has been compounded by Brexit and by Covid. For them it may take a few years to catch up on the experience of their more established colleagues.

Horizon is more than an academic programme – it is also industrial and about innovation.

Grant structures

The European grant structure focusses on commercial purpose, while in the UK the focus is much more on research purpose. Perhaps we have something to learn from Europe.

There are more excellent research proposals than there is available funding, even under Horizon. Yet there has been an underspend in the UK during our absence. Perhaps some of that underspend could be re-directed to some of these otherwise unfunded, but high quality, proposals.

Grants are not the only source of funding for research and innovation and it is important to take additional resources into account when formulating project proposals.

It is critical that we protect the research base, because this is what allows the UK to be excellent in Europe: we should not divert funding from that.

There is a broader problem about investment and capital investment in deep tech in the UK. The Government is currently looking at that including ways of creating better Government-enabled accelerators.

People in this country think that Horizon is an academic programme. But it is actually more than that: it is academic but also industrial and it is about innovation too. So all those sectors should be involved in it. In other countries there is not such a hard division between academia and industry – in Switzerland, nearly three-quarters of graduates go into industry. Here, we also need to be clear about ongoing support for innovation, through procurement and through regulation. □

FURTHER INFORMATION

Joint statement by UK Government and European Commission
www.gov.uk/government/news/joint-statement-by-the-european-commission-and-the-uk-government-on-the-uks-association-to-horizon-europe-and-copernicus

UK Association to Horizon Europe and Copernicus
www.gov.uk/government/publications/horizon-europe-and-copernicus-programmes-2023-uk-eu-agreement-explainer/horizon-europe-and-copernicus-programmes-2023-uk-eu-agreement-explainer

Applying for funding under Horizon
www.ukri.org/apply-for-funding/horizon-europe/apply-for-funding

Association to Horizon Europe
https://research-and-innovation.ec.europa.eu/strategy/strategy-2020-2024/europe-world/international-cooperation/association-horizon-europe_en

At the international climate conference, COP28, held in the United Arab Emirates at the beginning of December, a key focus was the financing of action both to mitigate the worst impacts and to adapt to changing conditions, especially among the poorest nations of the world.

The economics of climate change

The two-week-long COP28 conference in the United Arab Emirates got underway with the World Climate Action Summit, which brought together 154 Heads of States and Government. Among the milestones reached at the summit was an agreement on operational structure of the loss and damage fund and funding arrangements. It was the first time a substantive decision was adopted on the first day of the conference. Commitments to the fund of more than $700 million had been received by the close.

Climate finance took centre stage at the conference, with UN Climate Change Executive Secretary Simon Stiell repeatedly calling it the "great enabler of climate action."

The Green Climate Fund (GCF) received a boost with total pledges by the end of the event standing at $12.8 billion from 31 countries, with further contributions expected.

However, these financial pledges are far short of the trillions estimated to be necessary to support developing countries with clean energy transitions, implementing their national climate plans and adaptation efforts.

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Opening ceremony of the World Leaders Summit at COP28.

Economics and finance

The importance of economics and finance in delivering action on climate change was highlighted with the Royal Society and the International Science Council co-hosting a side event entitled 'Better understanding economic impacts of climate change and accelerating science-based climate action'.

Science is fundamental to global climate policy processes and action. The findings of physical climate science have generated a deep understanding of the very serious risks to human societies and ecosystems. Economists also have sought to understand and assess the economic impacts of current and future climate and to inform governmental and private sector policies, finance, and strategic decisions.

However, many economic assessments do not adequately reflect the scientific evidence of current and future climate change, often resulting in misleading portrayals of the possible economic consequences of climate change.

According to the Royal Society, this highlights the need for fundamental changes within science itself that would lead to a more enhanced inter- and transdisciplinary collaboration between physical science, economics, and other social sciences. This will be necessary in order to overcome the long-term disconnect that has existed between these disciplines and society in the context of climate change.

This side event presented key findings of the work undertaken by the Royal Society and the International Science Council on how to better understand economic impacts of climate change and accelerate science-based climate action globally.

The session focussed on a report that was developed from a two-day conference in March 2023, under the lead of Lord Nicholas Stern FRS FBA. The Royal Society brought together leading international experts from the physical sciences, economics, and other social sciences to discuss how to improve the understanding of economic consequences of climate change.

The findings outlined the key actions and research priorities needed to improve approaches to climate economics and increase climate action.

Climate change economics

Economic analysis and modelling are used to quantify potential changes in the economy, natural environment, and/or other social systems and to understand decisions and choices. Economists can also use analysis and models to estimate the economic impacts of climate change, due to, for example, increased temperatures and extreme events.

However, most current approaches to economic assessments of impacts of climate change do not reflect the severity of consequences that are suggested by

the latest physical climate science and evidence on impacts, due to a disconnect between the economics and physical sciences disciplines.

Missing aspects of the physical impacts of climate change include, for example, the full consequences of extreme weather events and the potential for cascading risks and tipping points. Interdisciplinary collaboration between physical scientists, economists and other relevant disciplines could help to better integrate the latest physical science into economic assessments, analytical approaches, and models, by sharing scientific evidence in formats that are more tailored to the needs of economists.

This dialogue needs to be two-way and address fundamental gaps in methods, such as by scientists and economists working together to develop new approaches to assessments. Working directly with decision-makers during the process of developing new approaches would further ensure their outputs address the information needs of decision-makers.

Many economic assessments of climate change adopt an approach based on standard welfare economics. As such, they do not take explicit account of the rights and obligations of current and future generations. Justice is in large measure about the respecting of rights. For example, many assessments focus on the consequences of climate change on overall or aggregated human welfare and discount the welfare and experiences of future generations using discount rates which have little basis in ethics, and which are inadequate in their treatment of potentially very bad outcomes.

The treatment of discounting is often cavalier for these reasons. Many economists are increasingly uncomfortable with the way and degree to which the future is discounted within standard welfare approaches and resulting consequences for policy.

Further, there are alternative ethical frameworks and moral philosophies that would re-shape climate change economics and drive discussions about, for example, what a virtuous society would do, or how to ensure that particular human rights are respected. Assessments could integrate non-welfarist approaches that value, for example, knowledge, culture and nature.

Uncertainty

Physical sciences and economics often address uncertainty by presenting a likely range of estimates. However, this can underplay the policy relevance of low-likelihood, or unknown likelihood, high-impact outcomes. This means policymakers may not be aware of possible outcomes outside of the indicated likely range of estimates, potentially leading to under-preparedness for more extreme scenarios.

One alternative approach could be the use of storylines, which use conditional 'if-then' statements to show a range of plausible outcomes, including low-likelihood, or unknown likelihood, high-impact scenarios. A storyline approach to communicating the risks of climate change could help policymakers to better prepare policies and actions which take account of the full range of possible scenarios.

The scale of recent changes across the climate system as a whole — and the present state of many aspects of the climate system — are unprecedented over many centuries to many millions of years. Economic assessments of climate change are often based solely on observed past data and rely on unrealistic extrapolation for estimating future economic impacts of climate change.

This results in a failure to consider outcomes that might occur under unprecedented levels of global warming. For example, projecting existing or past relationships of climate variability and migration may be less valid as variables that drive migration, including demographics and migration policies, are likely to change, possibly dramatically.

Addressing key research priorities would contribute to improving economic assessments of the impacts of climate change. Improved estimates would help to better inform strategic decisions for enhanced climate action. Such research priorities may include: integrating extreme events and other climate-induced hazards in economic assessments; understanding the impacts of Earth system tipping points and non-linear processes, and integrating these into economic assessments and; accounting for adaptation in economic assessments of climate change. □

https://royalsociety.org/news-resources/publications/2023/climate-change-economics

DOI: 10.53289/HBRL2155

ENGINEERING AND CLIMATE CHANGE

At the end of COP28, Professor Sir Jim McDonald FREng FRSE, President of the Royal Academy of Engineering, noted: "I am pleased to see the international agreement that was reached at COP28 after two weeks of intensive discussion, having included a firm commitment to move away from fossil fuels.

"Our world is already at a tipping point that requires our global leaders and our generation to transform the world from an economy driven and enabled primarily by fossil fuels to one powered by renewable sources of energy.

"As engineers we have a solemn responsibility to future generations to create a sustainable society in which our own economic development does not compromise their ability to meet their own needs. Transitioning to net zero, in both high- and lower- income countries, is in fact an opportunity to create new markets, innovative technologies and opportunities from which everyone can benefit. For example, offshore floating wind has enormous potential and could provide a practical route for oil and gas workers to transfer their skills to renewable energy.

"Engineering will be at the heart of the net zero transition and the commitments made today can only be achieved using a systems approach that considers this as a holistic environmental, social, policy and technological challenge."

- Other reactions to COP28 can be found at: **www.sciencemediacentre.org/expert-reaction-to-pledges-emerging-from-cop28**

CONTEXT

The healthcare system in Scotland, as in all parts of the UK, is facing major challenges, including waiting lists for operations, an aging population and shortages of staff. These are long term problems with no easy solutions. Increased funding and additional training of healthcare professionals are part of the answer. Another part is the greater use of data and technology.

The Foundation for Science and Technology, in partnership with the Royal Society of Edinburgh, held an event on 5 October 2023 to explore these new healthcare technologies, how they could be deployed, as well as the ethical, regulatory and practical issues involved in implementing them in the NHS.

The speakers at the event were: Jonathan Cameron, Deputy Director of Digital Health and Care, Scottish Government; Professor Patricia Connolly, Deputy Associate Principal, Biomedical Engineering, University of Strathclyde; Professor Oliver Lemon, Co-academic lead, National Robotarium; and Dr Ken Sutherland, President, Canon Medical Research Europe.

A video recording, presentation slides and speaker audio from the event are available on the FST website: **www.foundation.org.uk/Events/2023/Transforming-Scottish-Healthcare-%E2%80%93-The-Role-of-Dat**

The role of digital technologies in health and social care

Jonathan Cameron

Jonathan Cameron is Deputy Director of Digital Health and Healthcare, Scottish Government. He has overall responsibility for its Digital Health and Care strategy, and for major programmes of delivery. He has extensive experience in the application of IT and eHealth in various sectors, especially relating to health and care.

SUMMARY

- Scotland is aiming to integrate health and care provision
- Digital services like Near Me are already having a significant impact
- Advances in digital health and care technologies will also help to tackle the climate challenge
- An ethics framework underpins the Scottish government's digital health and care strategy
- A digital strategy must address the challenge of digital inclusion for all citizens.

Data and technology are really driving not just health and social care, but our everyday lives. Take the transformation that occurred during the Covid pandemic. There was an almost overnight shift to using digital tools and sharing of new data. As someone who led the development of the Covid vaccination system in Scotland, it was incredibly exciting to see how data and technology were changing and transforming the care of patients.

However, technology itself does not have to be high tech and we are always thinking about the best use of the tools that have been around for many years such as text messages.

The NHS Near Me service saw a remarkable increase in uptake during the pandemic. This is a video consulting service which is very easy to use for a wide range of people. It was particularly useful in areas like the Highlands and our island communities where travel is time-consuming and difficult. We have recently shared that over 60 million patient miles have been saved through the use of NHS Near Me which has great benefits for patients and our workforce.

This also demonstrates the power that digital and data have for the climate challenge, which is probably the next really big issue facing us. From a Scottish government perspective, there is a real opportunity to make a big difference by reducing the need for travel.

Underpinning our work is our data strategy. We launched this early in 2023 and it focusses on the need to empower people, allowing citizens to be in greater control of their own health and leading to better health outcomes. We want to make services and information more available in a safe and secure way and make a real difference to people's lives.

We also want to empower our workforce who are the lifeblood of our health and care services. From a data perspective, putting data and information and the right tools in the hands of clinicians, nurses and other staff will change and transform health and care for us all. We should not forget the contribution of industry and academia in making innovations and improved services available.

Underpinning the whole strategy, something we have placed at the centre of everything, is eth-

ics: we have to make sure we do the right thing for the right people. In addition, we have to bring the public with us and build trust. During the pandemic, we put in place an ethics framework to share with the public the reasons behind our actions, explaining why we were sharing data and how. We want to build on that and open up more sources of data.

One of our big ambitions for digital health and care in Scotland is our Digital Front Door programme. We will develop our health and care together, focussing on digital channels that help us do this. The ambition is to bring together health and care data in a way that will actually support the integration of those services. Individuals do not tend to differentiate between health data or care data.

The ambition of the Digital Front Door is to allow individuals to share the information they want with the doctor, the nurse, the physiotherapist or the care worker, without having to repeat the same story on every occasion: 'Tell us your story once and we will share it as needed'.

This should be launched before the end of the current parliamentary year. It also seeks to address the challenge of digital inclusion. We estimate that around 10% of the Scottish population either cannot engage with digital or else choose not to. We must make sure we do not leave anyone behind and there has been some great work done with our Digital Lifelines programme, in particular to encourage the homeless and those likely to need addiction services to gain access to support services. This allows earlier intervention and hopefully helps to mitigate the challenging situations they find themselves in.

Delivery plan

The Scottish Government has committed to an annual delivery plan for all of our digital health and care programmes. There are over 60 programmes within that plan, which sets out clearly what we expect to achieve, what we are working on, what the timelines are and when we expect to see the resulting benefits. Both that delivery plan and the data strategy are key documents for our engagement with industry and other partners.

These commitments cover a very wide range of items, from a new patient identity system right through to measures helping digitally-excluded people to access services.

However, we cannot deliver any of this without our dedicated workforce. I have to acknowledge that recruitment is not easy, especially in areas like cyber skills. We are therefore bringing different teams together to collaborate with each other, with partners, and with industry and academia.

SHUTTERSTOCK/ MONKEY BUSINESS IMAGES

Scotland's Digital Front Door aims to allow individuals to share information with a doctor, nurse, physiotherapist or care worker, without having to repeat the same story on every occasion.

Technology is being used to support collaboration across health and care. We are working with all 32 local authorities, the health boards and across Scottish Government to use quite simple tools like Microsoft 365 as a way of bringing people and teams together.

A new Masters programme called Digital Transformation in Health and Care in Scotland has been launched. It provides an opportunity to bring through the next generation of people who want to work in our sector. At Board level we have initiatives to deepen the understanding of digital, supporting leaders in clinical areas and in the care sector, helping them understand the opportunities that digital, data and AI can bring to improve the way that we work in health and care.

Industry and academia have an important role in supporting digital health and care. The Scottish government sponsors DHI, the digital health and care innovation centre. It also works closely with The Data Lab to understand new technology and potential applications.

During 2024, we expect to be launching the next round of CivTech challenges. CivTech is a Scottish government-led programme that encourages startups to develop new ideas in areas of the public sector where there currently are no solutions to specific challenges. One that we will be looking at in particular is around the issue of wellbeing, bringing innovation into health and care in a way that can change the lives of our citizens so that they live better, healthier lives. □

Links to the programmes mentioned can be found in the Further Information section on page 24.

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Delivering quicker, more effective treatments

Patricia Connolly

Professor Patricia Connolly FREng FRSE is Deputy Associate Principal of Biomedical Engineering at the University of Strathclyde, Director of Strathclyde Institute of Medical Devices, and the Chief Executive Officer of Ohmedics Ltd, a spin out of the University of Strathclyde. She is Deputy Associate Principal for Research and Knowledge Exchange at the university. She is also Healthtech Cluster Co-Lead.

We have many technologies already that allow us to monitor people's health. Some, like Covid tests, have been taken up by the public very quickly. In fact, blood pressure, partial oxygen, glucose, weight, urine infection, etc, can all be monitored quite simply.

The big tech companies have recognised the potential market in healthcare. Apple, for example, have made a success of their Apple Watch. Take a quick look at Amazon: there are all sorts of health offerings on their website, some of which are being used by parts of the NHS. Of course, Amazon is not the only one. Companies like Doccla have technology that can create 'virtual wards' at home, getting people out of hospital and monitored in a safe environment.

We are seeing real evidence of the benefits of home self-management from technologies like NHS Florence, a simple texting system. Give people the ability to self-manage and they can get much better outcomes. Take the management of urine infections for example: sepsis from urine infections affects 65,000 people a year in the UK (sepsis overall kills 50,000 per annum in the UK and 350,000 per annum in the USA). Early discharge, virtual wards or even non-hospitalised treatments with a paramedic checking stitches, etc, can help to improve outcomes across a range of conditions.

In the hospital environment, faster diagnostics and digital technology could mean that blood tests are complete by the time the patient sees their consultant and they do not have to return at a later date. Better prescribing is a potential result from some of these diagnostic tests, such as which antibiotic to prescribe for a really bad urine infection. New technologies can deliver better outcomes from less hospitalisation as well as reduced or more effectively treated chronic disease.

There is a great deal of innovation and development within universities. At Strathclyde, we have created the Centre for the Future Hospital, looking specifically at current problem areas. We will work with companies on virtual clinics, aiding rehabilitation, post-surgery and post-stroke treatments. All of these areas could be addressed more effectively in the home with greater use of digital technology.

Faster diagnostics and digital technology could mean that blood tests are complete by the time the patient sees their consultant

SUMMARY

- There is clear evidence of the benefits of health management at home
- Faster diagnostics can reduce the number of hospital visits
- More accurate assessment can improve prescribing of drugs and medication
- A 'triple helix' of collaboration between the universities, industry and the NHS is needed to maximise the benefits
- We need to give people the power to create their own wellness.

We are very interested in wellness: if the population does not buy-in to wellness, the NHS will not cope. Lifestyle diseases, often driven by a lack of knowledge in teenage years into the 20s and 30s, become chronic in the 30s and 40s: that should be unheard of in a modern society like ours.

The challenge is to get people truly engaged in this. Preaching is not the answer, it requires an holistic approach. It is a matter of finding what motivates people. Eudaemonia is the science of happiness. It says that a sense of purpose is a key element. How do we engender that in our communities? How do we give people the power to envision their lives differently and change, creating their own wellness? Citizen engagement is going to be critical to the survival of the health service over the next 20 years or so.

The triple helix

To deliver new technologies, we will need the 'triple helix' of collaboration between the universities, industry and the NHS. We need the businesses with the technology, agility and money to develop these things with the universities for the benefit of the health services. We must mesh these three groups together to create a coordinated system.

Sensors form one major area of innovation. Wearable or remote diagnostics are being researched, developed and commercialised by the Medical Diagnostics & Wearables Group in

APPLE

One high-profile wearable is Apple Watch, which allows users to enable high and low heart rate notifications.

collaboration with the Strathclyde spinout, Ohmedics Ltd. This has three platforms: one for wound detection and monitoring; one for bacteria monitoring (the next pandemic may well involve antimicrobial resistance so bacterial detection and identification needs to improve); and the third area is the futuristic 'don't take any blood, have a wearable sensor'.

If there is a sensor that can go inside a dressing, there is no need to take the dressing off for a patient, carer or attending clinician to measure the moisture and decide if the dressing needs changing. We estimate this could save up to half of all hospital dressing changes – and probably about the same in the community.

That of course is very disruptive, especially for wound care companies whose main business is to sell dressings, and patients would be able to take self-measurements to know when their dressing needs changing. In fact, these new technologies are breaking into areas where there are commercial and bureaucratic interests and ways of working. The NHS faces a great deal of change as it introduces these technologies.

In the second category, we have developed a small, portable and rechargeable sensor for home or pharmacy use that can analyse a urine sample. We have worked with NHS Ayrshire looking at wounds and with Glasgow Royal Infirmary for urine infections. The test takes about five minutes to administer and within 20 minutes it can tell if the bacteria has antimicrobial resistance to specific antibiotics.

Technologies like this will make detection and prescribing more accurate. Using them in the home will help avoid sepsis and other serious events that can occur with urine infections.

On the wearable side, we are working with DSTL, testing a wearable hydration sensor. Interestingly, there has been a great deal of interest from corporate wellbeing departments, looking to get their staff more engaged in personal wellbeing. If you can measure your hydration and perhaps food intake as well, this little tool can be used to motivate staff to take more of an interest in wellness.

This kind of wearable sensor with 'through the skin' diagnostics means it will not be necessary to prick a finger to monitor other parameters, glucose levels for example. We have also carried out a short trial in the Neonatal Intensive Care Unit at the Royal Hospital for Children with two of the consultants there. We wanted to see if we could use it to avoid taking blood from neonates who are sick and premature when they arrive in this unit.

Universities can help to develop and deliver technologies like this, working with the companies and creating spinouts. However, the adoption of new technology is still very difficult in the UK. When I came back to this country some 20 years ago, people were talking about the adoption of technology and how everything was going to be better. Unfortunately, I still hear the same statements today.

The challenges for the NHS remain: how to manage the interface with the commercial world; and how to attract the different types of worker required to implement the changes ahead. We will certainly see a change in the types of health and care delivered in the NHS. We need to create the right structures to deliver that. □

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Introducing generative AI into healthcare practice

Oliver Lemon

Professor Oliver Lemon is co-academic lead of the National Robotarium. His background is focussed on Artificial Intelligence (AI), bringing many years of experience developing machine learning and Natural Language Processing (NLP) models to better understand how robots can interact with humans using conversational speech in visual and spatial use. He is a former Senior Research Fellow at Stanford University and the University of Edinburgh, and Visiting Scientist at NASA. He is Chief AI Officer and co-founder of the conversational AI company Alana AI.

SUMMARY

- The challenge for AI developers is to embed it in real clinical practice
- Large language models can provide a wealth of tailored health information
- Hallucination – inaccuracies – and bias are two challenges facing wider use of AI systems
- A key element in successful AI usage is to ensure humans make the final decisions
- Co-design between developers and users will improve the final products.

There is a huge number of advances happening in AI currently, particularly with large language models (LLMs). ChatGPT is only a year old but its impact has been quite remarkable. LLMs are also known by other names: generative AI; foundation models; and the latest is 'large multimodal models'. Multimodal in this context means combining visual and language systems to generate descriptions of images and so on. All the big companies are working in this area. The challenge for this sector is to build these models into useful healthcare systems and to embed them in real practice.

These large language models can be used to provide all kinds of tailored health information. They can summarise complex documents, automate administrative tasks, analyse images, etc. In fact, they can be used in so many different ways that the challenge is to determine what to do first.

Over the past 20 years, researchers have spent a great deal of time building complex modular systems to understand and generate human language. In generative AI, humans can interact with these systems in a conversational way and, in addition, give them instructions to, for example, write an email to a doctor.

Conversational AI

A European project called RESQ+ is focussed on providing conversational AI for people who have had a stroke. The system asks them questions about their condition and the answers can be used as a way of assessing their condition and recovery. The project also helps them understand their condition. An app for mobile phones has been developed that patients can either speak to or type. A typical question might be: "What is aphasia?" If someone has had a stroke and now has aphasia, they may not remember what the consultant said so these answers could be very useful.

When the AI generates an answer, this will be based on a specific collection of documents, which it uses as a trusted source of truth. That is one way of dealing with problems of 'hallucination' – or wrong information – that can occur with large language models, although the problem has not been totally solved yet.

When the AI generates an answer, this will be based on a specific collection of documents, which it uses as a trusted source of truth.

The AI can also delve into quite complex questions such as: "What are the differences between Broca's and Wernicke's aphasia?" Here, the AI system has to carry out multi-step reasoning in finding the relevant documents, comparing them and then generating the right answer.

A recent version of GPT4 can automatically generate a radiology report from an x-ray image. The prompt or instruction to the system is to write a radiology report based on the image. Medical professionals can then check these generated reports. Sometimes there are errors which they can correct, but sometimes these reports are of high quality. Such reports would take a medical professional some time to produce but they can still be checked by humans.

How, then, do we fold these methods into existing workflows, so that people can use them to amplify and support their professional practice, making it easier for them to do their job more effectively and making it more enjoyable? AI needs to be fun to use if we want people to adopt it. The interactive, conversational aspect is one element of making people want to use this both in their jobs and their everyday lives.

Much is said about both the promise and the peril of generative AI systems. It is well known that they can hallucinate facts: they can generate text which reads well and is convincing but, in reality, contains errors. There are also known issues of bias where the models are trained on data which is discriminatory in different ways. Many people are now working on ways to improve the training data sets for such models.

SHUTTERSTOCK/ MAX ACRONYM

How can AI improve radiologists' assessments?

A very important issue is the concerns that the general public have about privacy and security. I work on projects where we put AI into hospitals. The key requirement is that no data is allowed to leave the premises. That means building rather small generative AI systems, which can be run on hospital premises without data being exported. But large amounts of data are still needed for model training. A significant effort has to be made to reassure the public that all the data we use is fully anonymised.

There is, quite rightly, a great deal of discussion politically about job displacement and how AI will alter the workplace. The challenge is to determine how it can augment people's existing jobs, helping them to become faster and more productive – and more fulfilled. AI needs to become a 'co-pilot' or 'buddy', helping to get the tasks done.

The UK National Robotarium, based at Heriot Watt University, is focussed on addressing the core AI problems facing robotics. Good robotics applications require computer vision, good planning, effective interactions with humans, an understanding of language and so on. These core AI issues are what make robots possible. This is, if you like, embodied AI.

Large language model systems are now being incorporated into robots. In one application, we have been able to generate facial expressions and robot gestures along with speech. This is used as a receptionist for the building. A similar system has been deployed in Paris, in a memory clinic at the Broca Hospital. This is an EU project called Spring. It captures patients' everyday questions, such as where the coffee machine is, where the lift is and which bus to get back home.

We have built this system to speak in French. Some large language models are multilingual and it was very easy for us to translate the system from English to French. In the hospital waiting room, it helps people to find out where to go next, where to get lunch, etc – it automates responses to these trivial but important questions.

Improving administration

There is a huge opportunity here, not only in humanoid robotics and human-robot interaction, but for the more mundane and boring administrative tasks – such as automatically generating patient notes and records to improve efficiency.

In trying to keep the risks balanced, a key element is to always keep a human in the loop. There can be an AI co-pilot, or an AI can be part of a team of humans but, ultimately, humans must make the final decision.

Co-design will improve these systems. Academics are talking with healthcare professionals to create systems that will be useful to them, make their jobs better and more interesting, and ultimately improve patient outcomes. □

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Creating AI models that meet developing healthcare needs

Ken Sutherland

Dr Ken Sutherland FREng FRSE is President of Canon Medical Research Europe and Assistant to the Chief Technology Executive of Canon Medical in Japan. He serves on the MRC's Translational Research Group and is an adviser to EPSRC. He studied Electronics and Computer Science at Edinburgh University and gained a PhD in image analysis with four years postdoctoral research experience in medical image analysis.

SUMMARY

- To create unbiased AI, large volumes of data are needed
- AI can free people from more mundane tasks
- The NHS needs AI support to meet increasing demands for healthcare
- By keeping NHS data in a safe haven, citizens' concerns about security and privacy can be addressed
- By combining learning from different population sets, more widely applicable AI can be developed.

There is a real challenge in sourcing data in sufficient volumes to train AI models in a safe, secure and appropriate way. That is, one which maintains the integrity of the data, while understanding that if we do this badly, we create biased solutions that will not work effectively and will actually increase health inequalities.

Canon Medical is a division of Canon, the multinational organisation that makes printers, scanners, photocopiers and document-imaging solutions. The company was originally formed over 30 years ago by two graduates from the University of Edinburgh. It now employs about 140 people, is still based in Edinburgh and is now part of Canon. We work with universities every day and we work very closely with NHS and Scottish Government colleagues.

So our world is imaging. We can produce the most modern 3D visualisations. Yet beautiful pictures are not the point. We want to help humans to work as efficiently as possible by automating some of the more mundane tasks and allow patients to progress through the healthcare system as rapidly as possible. The demographic challenge facing the health service is unsolvable without more technology. There are just too many of us living too long in need of healthcare – and not enough doctors and care staff to look after us. It is simple to state the problem but not so easy to solve. Part of the solution, though, is AI.

We want to help humans to work as efficiently as possible by automating more mundane tasks.

Centre of excellence

Canon, as a multinational healthcare business, has decided to put its AI Centre of Excellence in Edinburgh. That is because of both history and also the opportunities in Scotland to work with the universities, the NHS and the Scottish government.

The timing of that decision was fortuitous. About five years ago, money became available from Innovate UK as part of the Industrial Strategy, which included a lifesciences sector deal. This stressed the place of AI and agreed to fund a number of centres to look at AI within healthcare. One of these was in Scotland. The Industrial Centre for Artificial Intelligence Research in Digital Diagnostics (iCAIRD) brought together different organisations supported by Scottish Government, including multinationals like Canon and Philips, as well as Nvidia who make the computer platforms used for AI nowadays.

It took a couple of years to advance from the original idea to a large-scale project. Funding was originally about £15 million, with £10 million from Innovate UK who recognised our ability to create this consortium in Scotland.

There were two parts to the project. The first was radiology imaging, the second was pathology, examining histology and microscope slides.

The radiology started off as a relatively modest project, with three different exemplars in the Glasgow and Grampian regions, supported by the relevant NHS bodies and universities. The project ran for an extra year because of Covid and it delivered far more than originally envisaged. It resulted in a Covid work package in addition to other work packages as well, a much bigger and more comprehensive programme of work that is still continuing.

There were even smaller ambitions for pathology, working initially in Glasgow with Philips. Again, though, a large network of projects developed.

Success was due to the fact that the model was different from that previously used for AI training in healthcare. Instead of a company approaching the NHS and offering to use their data in the company's data centre, on company in-house computers, we did the opposite. The NHS kept their data in their own safe and secure environment. We went to them, logging into their systems securely and we

carried out our AI training within that safe haven.

That approach has been transformational. It respects the ownership and privacy that are so important to citizens: this is their data and nobody else's.

Also, the AI is not being trained with cleansed exported data, it is taking the real data as it is. That is important because an algorithm trained on real data will work on real data. Create a completely sanitised view of the world and train the AI in that world, then it will likely fail in the real world because the real world is not sanitised.

Other people recognised that what we were doing was different and they came here to Scotland to work in this way too.

Canon has helped develop the safe haven AI training platform called SHAIP. Pathology Lab was able to digitise a large number of slides, creating a digital archive that is now available for research and ongoing use. A number of different partnerships and collaboration models have also been established: we started off with 15 partners and £15 million funding but we have ended up with 40 partners, £25 million and about 250 staff. We also have access to 75 million medical images and when it comes to training data, the volume is the most important factor.

Networking

A further offshoot from the original project has been delivered in Aberdeen under the Opportunity Northeast programme. This was funded under the Small Business Research Initiative (SBRI) with support from Scottish Government. Around 100 companies came to Scotland for the teaser session to understand the opportunity. We have created a reason for people to come here: there is the availability of data and a triple helix model of collaboration – academia, business and the NHS.

It is said that imitation is the most sincere form of flattery. So we were delighted when NHS England decided to launch a scheme including a network of 'secure data environments'. They backed that with a budget of up to £200 million in funding. This is exactly the model that has been piloted in Scotland with iCAIRD (Industrial Centre for Artificial Intelligence Research in Digital Diagnostics). There will be regional centres where innovators can access data, be they businesses, academics or just an independent person.

A technology called federated learning allows individual pools of data to be connected together. So this is not just about creating a piece of AI that is trained in Aberdeen but which will only ever work in Aberdeen. If AI is to apply globally, it has to be trained on a representative global population or it will not work.

ICAIRD

SHUTTERSTOCK/ SARAYUT_SY

Scotland's iCAIRD is working with federated learning to allow individual pools of data to be connected together securely.

Now, it is just not realistic to have large international pools of data that people can access. What is realistic, though, is for a company or an innovator to do some training here in the UK with the NHS, then go to the US, to China, to Russia in order to build a representative population for the world. England is doing it. Scotland is committed to doing this as well. Making this data available will enable the level of applicability of AI algorithms to be much higher. That will benefit users of the health service across the country. □

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The debate

Following the formal presentations, the speakers joined a panel to respond to questions from the audience on topics including: verifiability of data; precision medicine; regulation and training; encouraging wider adoption.

Many people have already embraced the use of apps and technology. Yet there are always more opportunities to harness data. In Scotland there is also a focus on mental health and using data-driven technology to support the individual.

Public Health Scotland is using a series of datasets to help them advise and convince policymakers, supporting their arguments with evidence. It is very important that this data is independently audited. That helps to build trust.

One of the aims is to aggregate different datasets about individual patients in a safe way so that they can still be linked. Precision medicine refers to using essentially all the available data about an individual patient and then developing a personalised care or intervention plan for them based on their characteristics. To do that involves bringing all the relevant data together from different sources. That is not just the healthcare data, but also social care data, the socio-economic grouping, even the postcode – all can have an effect on health.

Some applications of AI will be relatively easy to fit into everyday life in the kinds of systems already in use. But in others, developers have to work together with professionals on new areas and that will mean training people specifically to use these methods. Regulation is important and not just in fields like medical diagnostics.

Part of the power of conversational AI is that it provides a universal interface between the systems and the users. The implementation of many of these new systems will not be provided by their academic developers but by commercial companies. Academics will be working with companies to get training packages together and to meet the medical legislation which requires that users are trained to use devices or technology.

The NHS is not monolithic: it is, in fact, a very large conglomeration of different organisations, each with its own culture, each of them want their own data. Government has failed to roll out new devices or technologies because there are no requirements on all these players to adopt them. The savings are there to be made but there is no coordination or 'push' from the top. At the moment, people can simply choose not to adopt something because it does not suit their existing routine.

The scientific community is in the process of learning what AI should – and should not – be able to do, yet there are already amazing results. A general model for image recognition, trained on pictures of cats and dogs on the internet, is actually very good at recognising anatomical structures in radiology imaging. It just needs a small amount of additive data that is specific to radiology. The key is to understand the capabilities in order to use it in a safe and appropriate way. ❐

FURTHER INFORMATION

CivTech www.civtech.scot

Digital Front Door www.digihealthcare.scot/our-work/digital-front-door

Digital Health and Care Innovation Centre www.dhi-scotland.com

Digital Lifelines Scotland https://digitallifelines.scot

Doccla www.doccla.com

Health and social care: data strategy
www.gov.scot/publications/data-strategy-health-social-care-2

NHS Scotland: Near Me www.nearme.scot

RESQ+ https://www.resqplus.eu

Spring https://spring-h2020.eu

The Data Lab https://thedatalab.com

The National Robotarium https://thenationalrobotarium.com

FST PODCASTS

Professor Dame Anna Dominiczak - Innovation in healthcare and in the NHS
www.foundation.org.uk/Podcasts/2024/Professor-Dame-Anna-Dominiczak-Innovation-in-healt

Professor Clive Badman - Healthcare Technologies
www.foundation.org.uk/Podcasts/2023/Professor-Clive-Badman-Healthcare-Technologies

Dr Marion Slater - Healthcare in Rural and Remote Scotland
www.foundation.org.uk/Podcasts/2023/Dr-Marion-Slater-Healthcare-in-Rural-and-Remote-Sc

In a rapidly changing society, how can the major scientific challenges facing us be effectively tackled? The 2023 Foundation Future Leaders Conference explored how the next generation of researchers, political and industrial professionals can make a positive impact. Charlotte Raynsford reports.

Balancing risk and resilience

With the overarching theme of 'Risk and Resilience', leading thinkers, policy- and decision-makers took delegates on a deep dive into the key issues of AI, the future of work, and energy security at the 2023 Foundation Future Leaders Conference.

Over 100 early- and mid-career professionals made their way to Glaziers Hall, London, on 20 November 2023 to hear from speakers including Professor Helen Margetts OBE, Director of the Public Policy Programme at The Alan Turing Institute, and Professor Paul Monks, Chief Scientific Adviser at the Department for Energy Security and Net Zero. This, the fourth annual Future Leaders Conference was organised by members of the 2023 cohort and designed for delegates at a similar career stage.

Setting the scene, Dr Luke Reynolds MBE, Head of Policy – People and Planet at The Royal Society, gave an insight into some of the upcoming challenges at the science and policy interface. Exploring the importance of linking new science and technology with existing social need, he told the audience: "When you're thinking about your careers and science-policy interface… think about balance and that matching process because that's where you will derive and give value."

The programme began with a discussion on AI and its place in society.

Artificial Intelligence

The programme began with a discussion on Artificial Intelligence and its place in society. Professor Helen Margetts from The Alan Turing Institute and Esra Kasapoglu, Director of AI and Data Economy at Innovate UK led the session. Professor Margetts began by unpicking the definition of AI, as well as the risks and controversy surrounding the topic, and discussed recently obtained survey results into how people really felt about it. The survey, which was undertaken jointly with the Ada Lovelace Institute, showed that people were particularly excited about AI in health research. They also saw possible benefits in education with the use of virtual reality. However, there was concern around advanced robotics, with over 60% of people saying that laws and regulation prohibiting certain uses of technologies, while guiding the use of AI technologies, would make them feel more comfortable.

Professor Margetts then went on to talk about the ethics of AI. She said: "AI technologies can introduce bias ... They are based, after all, on human decisions from the past, and many of those were biased. So that means the decisions the technology makes may also be biased. They cause accountability problems. They cause transparency problems … Those are all things that need to be thought about and built into the design, development and deployment of these technologies." Her team has carried out a great deal of work on these matters and had produced the UK Government's official guidance on AI ethics – the first guidance of its kind in the world, and the most downloaded.

Esra Kasapoglu from Innovate UK, added that: "AI has started to unlock some of the biggest opportunities in the world, including fields such as life sciences and pharmaceuticals … We need more and more scientists to get engaged in making these discoveries which can change people's lives not just in the UK, but globally."

The future of work

The second session looked at the future of work. Foundation Future Leaders Programme member and session Chair, Eun Sun Godwin, noted: "We are living in a society and time where the understanding, perception, environment and the landscape of work is radically changing."

Delegates heard from a range of guest speakers, including Toby Peyton-Jones, whose experience as a zoologist provided material for several evolutionary animal-related examples. Talking on the current speed of change, which he called "astonishingly complex," he said: "Any animal's response to this kind of rapid change is fear." His three key principles of advice to survive and stay relevant in an uncertain future, were: stay broad; have a strategy rather than a plan; and remember that 'context is king'.

Professor Jillian MacBryde, Director of the Hunter Centre for Entrepreneurship and Professor of Innovation & Operations Management, University of

From top left: Future of Work panel speakers Toby Peyton-Jones; Professor Jillian MacBryde; Dr Rhys Morgan. From bottom left: Energy Security panel speakers Professor Jim Watson; Dr Joanne Wade; Professor Paul Monks

Strathclyde, highlighted the changing face of manufacturing in the UK. She said that there needed to be a perception change within industry and a greater understanding of what people value in their jobs. The session was closed by Dr Rhys Morgan, Director of Engineering and Education, Royal Academy of Engineering, who focussed on the future of responsible engineering. His four major vectors of change included: global responsibility; including the fundamental changes needed to reverse carbon emissions produced by engineering; systems thinking for more ethical decision making; and the importance of inclusive thinking when designing products and engineering goods and services.

The future of energy

In the afternoon, delegates heard first from Professor Paul Monks, Chief Scientific Adviser at the Department for Energy Security and Net Zero who gave a 'quick canter' as he described it into the world of energy security. He described what the uninterrupted availability of energy looks like today, and what it will look like as the UK transitions to a more sustainable future.

He explained that alongside economic and societal impacts, the global energy system must show resilience to weather and a changing climate. He gave a glimpse into what the UK (by then, highly-electrified) energy system will look like in 2050, and explained that what we will see is a fundamental shift in our net-zero world from a carbon intensive, centralised generation to a much more complex system that is low carbon, interconnected, more distributed. He stressed that this will need a lot more energy storage – a topic he is deeply immersed in.

Professor Jim Watson, Director of the Institute for Sustainable Resources at University College London, talked through some additional features he felt were needed in the next stage of transitioning to low carbon sources. He pointed out that in our globalised world, having UK energy independence was not going to happen any time soon and that any transition to low carbon sources needed to take into account the nature of our interconnected world. Professor Watson also discussed how we should manage the decline of fossil fuels in the UK and the risks to any new system, such as recent, well-documented cyber-attacks.

Completing the session, Dr Joanne Wade OBE, Chief Strategic Adviser at the Association for Decentralised Energy, painted a picture of what an energy-secure home would look like for the average householder in a net-zero world. She stressed the importance of talking to social scientists when creating an optimal energy system. She concluded: "If we're going to deliver an optimal net-zero energy system (not just a functional one), we all need to take the time to understand, to listen, to talk and to understand each other a bit better. If we do this, we'll be much more likely to design a system that doesn't only deliver net zero but also ensures resilience, affordability and security, both for UK plc and for every single household within it."

The session was followed by a vigorous panel discussion and debate, led by members of the 2023 cohort of the Foundation Future Leaders programme. □

DOI: 10.53289/TLDA5122

The sessions were recorded and are available on the Foundation website at: www.foundation.org.uk/Events/2023/Risk-and-Resilience-Foundation-Future-Leaders-Conf

CONTEXT

Low productivity is a foundational cause of Britain's recent economic malaise and raising it is a top priority for policy makers. Public and private investment in research and development is a key route to boosting productivity and future economic growth. Yet businesses often complain that policy makers are failing to create an environment that encourages private investment. Within this environment, the Office for National Statistics have recently revised figures for the levels of UK spend on R&D.

On 15 November 2023, the Foundation for Science and Technology, in partnership with the Resolution Foundation, organised a discussion event to explore issues such as how the UK's performance in R&D compares with other advanced economies, what barriers need to be overcome to boost R&D spending and how this R&D spend aligns with a wider economic strategy focussed on boosting growth.

The speakers were: Grant Fitzner, Chief Economist, Office for National Statistics; Professor Jonathan Haskel, Professor of Economics, Imperial College; and Professor Dame Ottoline Leyser, Chief Executive, UKRI. A video recording, presentation slides and speaker audio from the event can be found on the Foundation website at: **www.foundation.org.uk/Events/2023/Inventing-a-Better-Britain-How-does-R-D-fit-into-a**

Revising estimates of R&D spend

SUMMARY

- ONS has revised R&D estimates significantly upwards
- Small firms were notably under-represented
- The revisions indicate targets for Government R&D are being met
- Sampling for the business survey is being expanded
- There is a strong correlation between R&D spend and productivity.

Grant Fitzner, Chief Economist and Director of Macroeconomic Analysis at the Office of National Statistics, outlined the reasoning behind a recent significant upward revision to R&D estimates by the ONS, including the actual changes that had been made, before describing the next steps to be taken.

He explained that the figures could be broken down into several categories of R&D: business, Higher Education and Government. He made the point that business accounts for around 70% of the total research and development effort in the UK, while Higher Education is around 23%, Government expenditure is 5% and the remainder comes from the nonprofit sector.

Business and Higher Education therefore dominate UK spend and activity, as is the case in most other countries. That had therefore been the main area of focus for ONS. Looking at business activity, the first part of the ONS review and subsequent revision of R&D reporting involved addressing the under-representation of small firms.

Joint work with HMRC identified which firms and which sectors were missing from ONS figures. Estimates were uplifted and reweighted. This work drove a £17.1 billion upward revision to the 2020 business R&D figures.

For Higher Education, ONS is now using Transparent Approach to Costing (TRAC) data from the Office for Students. This is providing a much better picture of R&D activity carried out within HE. It has led to a revision of around £4.9 billion in spending.

ONS has also been scrutinising Government R&D, looking particularly at micro-data from the Departments most heavily involved in this area. The results of the revised analysis here were published in April 2023.

Significant changes

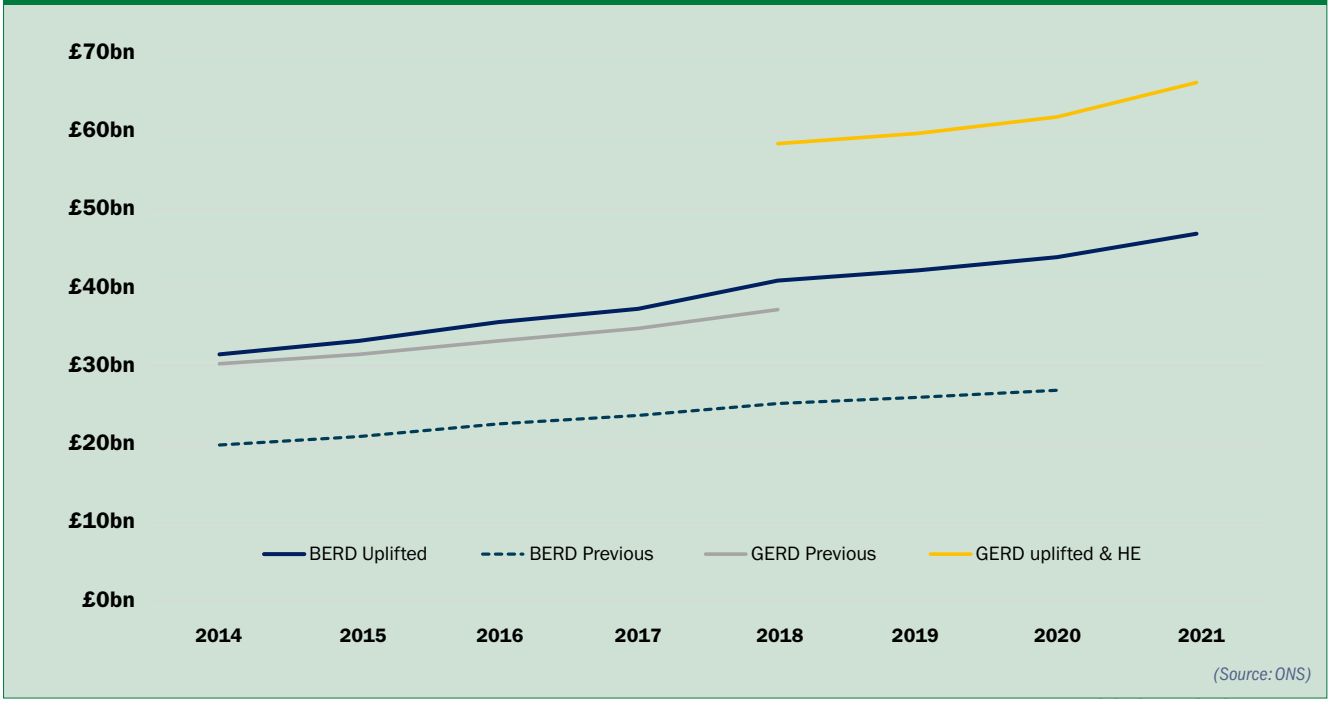
So there have been quite a few changes. Figure 1 illustrates the results. The grey line shows the unrevised Gross domestic expenditure on research and experimental development (GERD). The dotted and blue lines show the previous and revised Business Enterprise R&D (BERD) while the amber line shows the revised GERD including the uplift from revised HE figures mentioned previously. These are significant upward revisions.

The Government has a target of investing 2.4% of GDP in R&D and on original estimates the UK had been tracking below that level for some time. These revisions have lifted the UK above that: in 2021, this was just under 3%, slightly better than the OECD average but still somewhere near the middle of the pack. These revised figures indicate that the country is not an outlier on the international stage.

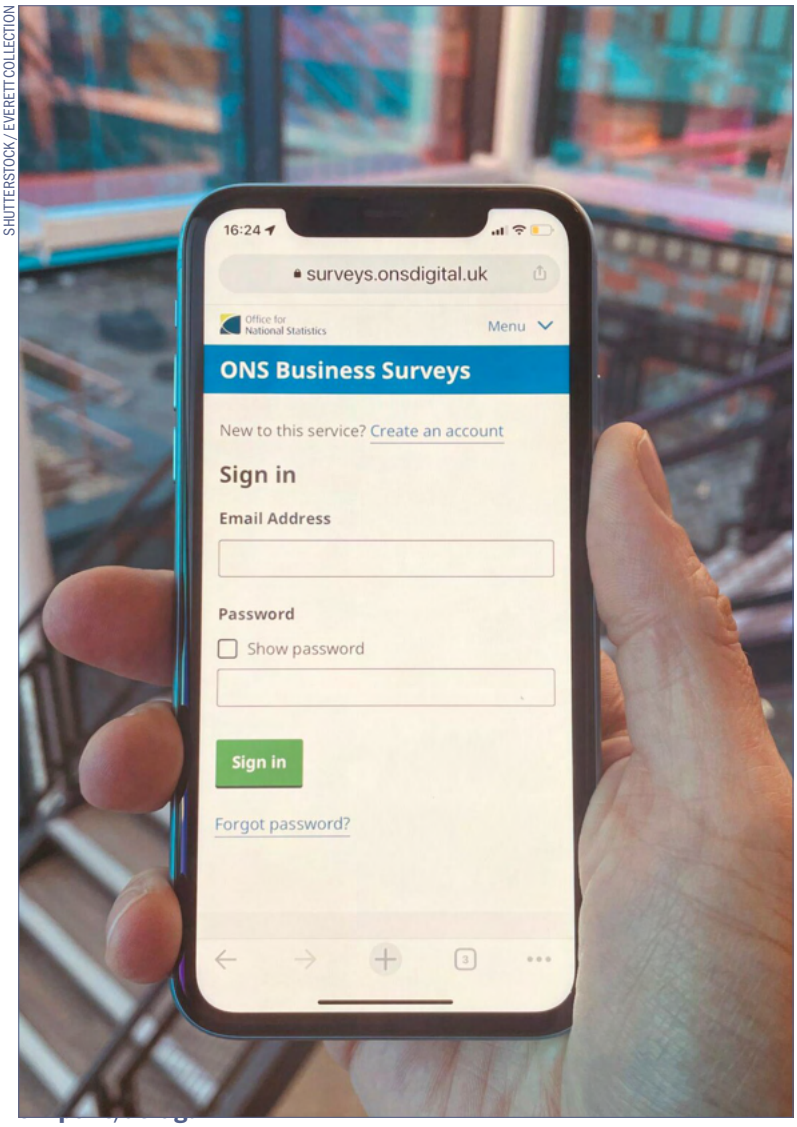
The first phase of this exercise was concerned

The revised figures indicate that the UK is not an outlier on the international stage.

Figure 1. UK R&D – National Statistics



(Source: ONS)



SHUTTERSTOCK / EVERETT COLLECTION

Following its revisions to overall R&D expenditure, ONS has been focussing on expanding its Business Survey (left).

with getting the overall numbers right and resulted in significant upward revisions. Phase two has involved a large expansion of the Business Survey. ONS has increased the sample size tenfold and will be publishing results from the new enhanced survey in 2024.

Granular data

On Government subnational measures, a key question for the Levelling-Up agenda is where exactly the R&D spend is occurring. ONS is developing more granular data sources and working with the Government Office for Science to answer that question. International experts are helping to develop a better understanding of the UK's alignment with international best practice in measuring the right things.

These statistics will feed into the 2024 Blue Book revisions.

Grant Fitzner noted that people started talking about R&D seriously about 30 years ago (there is a large body of literature on this subject). There has been a consistent strong correlation between R&D spend and productivity. This is of considerable interest in the UK at the moment, given the disappointing productivity performance of late. □

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The intangible aspects of R&D

Jonathan Haskel

SUMMARY

- Calculating real R&D depends on a number of factors
- International comparisons are complex
- There are a range of intangible goods that are not all captured in GDP
- Productivity gains are not solely due to innovation
- There are opportunities to improve productivity in traditional hard to improve sectors.

How do the R&D revisions being made by ONS change our view of UK performance? In the figures published by OECD in summer 2022, the UK lags behind its competitors. Use the revised ONS figures, however, and our R&D looks rather better. Yet if the back series has not been updated, we cannot see the whole story. Indeed, the overall picture has a number of moving and interconnecting parts.

If the data were backcast, what would it look like? It might be reasonable to draw a line back from the point at which the revised ONS figures appear to the date at which the R&D tax credit began, around the beginning of the century, so that the original and revised lines intersect. That might provide a broader picture of how things have developed.

The next moving part is to convert the nominal R&D spend, in pounds and pence, into real spend accounting for inflation. We have to divide the nominal amount by a deflator in order to get real euros, real pounds, real dollars, etc. However, there are a variety of R&D deflators used across different countries. So, there are differences between countries about how this nominal spend converts into real money.

The official UK deflator rate rises particularly sharply after 2015, which means essentially, that the UK trend of R&D is determined by an aggressively rising number: the result being less real R&D than other countries – another moving part!

We need then to understand not just the nominal R&D figures, but also how the real underlying R&D figures are calculated, which makes international comparisons extremely difficult.

Looking at recent R&D investment, for example, it is clear that post-Brexit investment was much flatter relative to the previous trend. That is part of the economic reality we are living in.

Intangibles

That is conventional R&D. Now, do the same exercise on intellectual property, which includes R&D on software and artistic originals, and the numbers look very similar. However, there has not been much change in the trend for these materials, which suggests that maybe Brexit did not have so much of an impact (although that reignites the debate on how this is all measured and is it being done in a consistent manner).

Professor Jonathan Haskel is an external member of the Monetary Policy Committee of the Bank of England. He is Professor of Economics at Imperial College London. He was previously Professor and Head of Department at the Department of Economics, Queen Mary, University of London. From 2016 to January 2023, he was a non-Executive Director of the UK Statistics Authority. Between 2001 and 2010 he was a member of the Reporting Panel of the Competition Commission (now the Competition and Markets Authority).

Table 1. Key features of reporting

Category	Asset	Included in national accounts
Computerised innovation	Software and databases	✓
Innovative property	R&D	✓
	Artistic originals	✓
	Design	×
Economic competencies	Firm-specific training	×
	Branding (advertising and market research)	×
	Organisational capital	×

It is necessary to build a broader understanding of the kind of knowledge economy that we are moving into, and its implications.

The modern economy is indeed a knowledge economy – and R&D is an important part of that knowledge. Yet it is just one area in a whole group of intangible investments. These include software, databases and artistic originals which are included in GDP numbers, but other types of knowledge such as investment design, training, branding, business process reengineering under the name of organisational capital – these are not included (see Table 1, p29).

R&D and beyond

It is necessary to build a broader understanding of the kind of knowledge economy that we are moving into, and its implications. Looking specifically at R&D, a great deal is still carried out in manufacturing, in aerospace, in chemicals, etc. Yet there is also a great deal of investment in economic intangibles, in particular in the service sector.

That suggests, if one wants to understand productivity in the service sector, it is not only R&D that is important but also this broader range of investments as well.

The evidence suggests that public sector R&D is complementary to that in the private sector and that it spills over and benefits the private sector as well. If there is one thing that investment needs, though, it is stability. The uncertainty and the instability that has been affecting the economy for various reasons has hurt investment.

AI, artificial intelligence, also has a role here. It is, of course, embodied in software and in databases, which is captured in the existing data. However, the broader issue with AI is whether AI is itself an innovation in the way of doing innovation. It may help the scientific community to innovate much more quickly. It could then be a source of future productivity in its own right.

Finally, looking at intangibles outside the manufacturing sector, that opens up the possibility of achieving productivity gains in what have hitherto been rather hard-to-improve sectors such as health. □

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Creating a stable framework for success

Ottoline Leyser

Professor Dame Ottoline Leyser DBE FRS is the Chief Executive of UK Research and Innovation (UKRI) and Regius Professor of Botany at the University of Cambridge. She has a long-term interest in research culture and its effects on the quality and effectiveness of the research system. She chaired the Nuffield Council on Bioethics project examining these issues. She is a Fellow of the Royal Society, a Member of the Leopoldina and EMBO, and an International Member of the US National Academy of Sciences.

SUMMARY

- Productivity in the UK is flatlining
- The Science and Technology Framework has been developed to address this
- Interventions need to be carefully aligned if they are to deliver the desired results
- UKRI reaches across all sectors of the economy and is uniquely positioned to support delivery of the Science and Technology Framework
- Confidence and stability are essential to stimulate private sector investment.

Looking at international comparisons, the UK economy is flatlining in terms of productivity. That presents a real challenge. One of the results of the revisions to the ONS figures is that, while previously there was an argument that low public sector investment was the cause of our poor productivity, that is not a convincing argument anymore.

So, we have to revisit the reasons behind that flatlining productivity. There has been significant work undertaken in Government, driven by the Government Office for Science under Sir Patrick Vallance. This resulted in the Science and Technology Framework, which has effectively become the manifesto for the Department for Science, Innovation and Technology (DSIT).

Science and Technology Framework

The Framework sets out 10 systems interventions that are needed in order to deliver the high-productivity, high-growth economy that we are seeking. Importantly, these 10 interventions in the research and innovation system are not standalone actions but must be aligned in order to deliver the high-growth economy that the country needs.

I picture this as a triangle. The three points are: high-productivity, innovative, high growth, businesses with high-quality jobs; high-quality, high-productivity, innovative and affordable public services (including, for example, the National

Health Service, but also national security and so on). Then the third point of the triangle comprises highly-skilled, healthy, prospering people.

Those three elements are deeply interconnected. The highly-skilled, healthy, prospering people do jobs in businesses and the public services, but working in innovative businesses supports the wellbeing of these people. Evidently, the public services support health, education and skills.

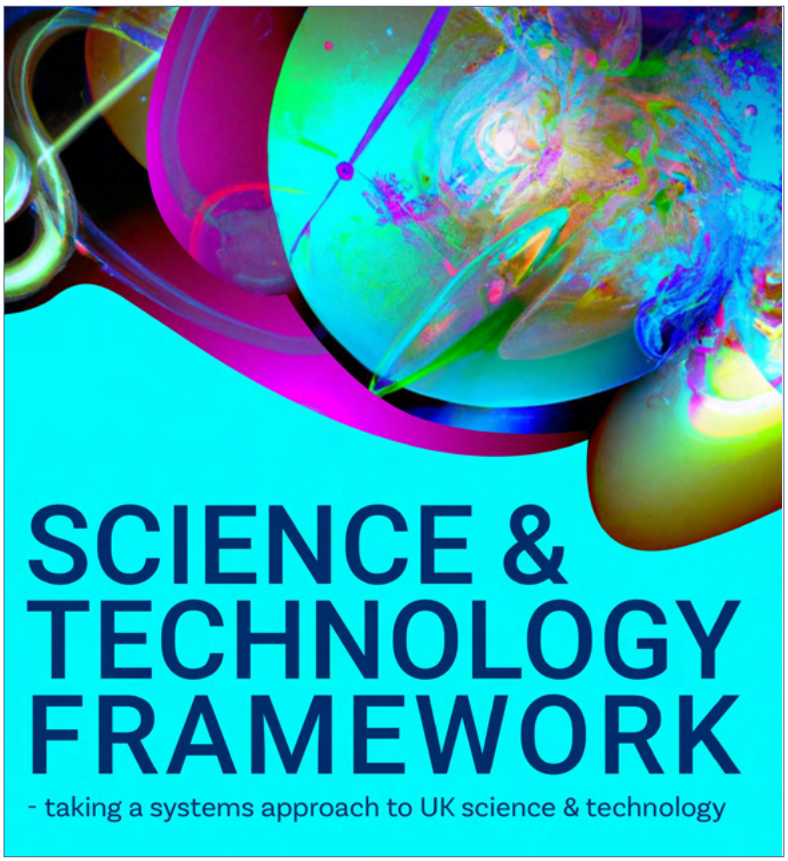
As a country, we need to connect those three corners properly so that they support each other and help to drive up productivity and growth. Unfortunately, the thinking is not always joined up in the most effective way. Take the way that public money, such as tax revenues, is invested. We get tax income from our high-productivity, innovative businesses and the jobs that they create. This money is used to support public services. However, take too much money out of businesses in order to support the public services and there is a danger of becoming trapped in a debt spiral, which results in insufficient investment in both areas.

We need to think much more imaginatively, using the 10 elements of the Science and Technology Framework to shape the way we invest those tax pounds. For example, and perhaps most obviously, if we think about using public procurement really wisely, one would invest in the procurement of products for public services in a way that actually supports high-productivity, innovative businesses. By procuring products and services from these businesses for public services, the tax income spend through public procurement would flow back from public services to businesses, rather than just being taken from businesses to give to public services.

Public investment

Public investment in research and innovation is another crucial way in which tax spend can be invested wisely to support the three corners of the innovation triangle. R&D investment supports so many different elements of the Science and Technology Framework.

It supports skills. UKRI invests in research projects in universities or public sector research establishments, wherever they are. There are skilled people learning through the research and innovation that they conduct. If they can move freely through the economy, through businesses and the public sector, then we can drive the adoption and diffusion of new technologies, for example, across the system. Investment in skills is necessary therefore, but there must also be additional aligned incentives to carry these people across the system rather than locking them in to specific places and programmes.



That is the difference that UKRI can make. We account for nearly half of all public sector spend on research and innovation. As we span all disciplines and all sectors, UKRI has the opportunity to build a fully aligned portfolio of investment across the many elements needed by the Science and Technology Framework: skills; infrastructure; discoveries and new ideas; and innovation. This investment can be used to target particular priorities and technologies where we have a comparative advantage, such as AI.

UKRI has the opportunity to build a fully aligned portfolio of investment across the elements required by the Science and Technology Framework.

Our portfolio of investments can move this process forward in a balanced way, aligning them with incentives that connect up the three corners of the triangle and drive the shifts in the economy that we want to see. Through these actions, we build confidence and the stability in the system which stimulates and leverages private sector investment. And that, after all, is where the vast majority of investment will continue to come from.

The Science and Technology Framework, with its 10 core elements, is essential if we are to build that stable platform. Infrastructure, regulations and standards, with clear long term signalling about tech prioritisation, deep international engagement, skills and innovative public services – all these have to be linked together in order to build the foundation upon which private sector investment can flow with confidence. That is the goal. □

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The debate

Following the formal presentations, the speakers joined a panel to respond to questions from the audience on topics including: tax credits; spinouts; scaling up; silos; new fields of technology; and challenge-led funding.

One of the issues with R&D tax credits is that, while they seem to work well for small firms the picture is not so clear for big firms. Many big firms are carrying out R&D anyway. But we should not be subsidising activity which would have been undertaken in any case. The UK is, in fact, unusual in the amount of tax credits for R&D it offers. Supporting the five priority technologies in the UK Science and Technology Framework is easier through direct investment than through tax credits.

Spinouts

What should be done about all the successful university research spinouts who are sold to a foreign corporation? This reduces economic benefit because they do not stimulate long term growth in the UK. It is one aspect of the UK system that is currently not producing results for the UK economy. The problem is not with the spinouts – the UK does very well at spinouts – the problem is with scaling up. So there is a great deal of wonderful R&D in the UK, but manufacturing then takes place overseas, while most of the value capture is in manufacturing. High value-added manufacturing brings a great deal of economic benefit to the country hosting it.

Our system is siloed. People go to university and never leave. If they do leave, they go to a business and stay in business. There needs to be much more movement of people between academic, business, policy and investor sectors. With the right churn of people, the whole system would be better connected.

SHUTTERSTOCK/SOMYUZU

AI is going to have a dramatic impact on the way that we are able to do science.

In all areas of investigation, where there is a new way of thinking about a subject, this will drive discoveries incrementally for a while and then they will plateau. For example, AI is going to have a dramatic impact on the way that we are able to do science, the amount of money it will cost. In that area, scientific productivity is not going down. In addition, discoveries like AI have revolutionary impacts and create whole new fields.

Private investment will always provide a higher proportion of R&D than public investment. But if the balance is right, then productivity will increase which in turn will generate more national wealth to invest. Challenge-led funding has been very successful in leveraging private sector investment and indeed, in driving those investments through very rapidly to products in the market. In the end, though, success is dependent on people and we have to think about the place that innovation has within our culture and our society. ❑

FURTHER INFORMATION

UK Science and Technology Strategy
www.gov.uk/government/publications/uk-science-and-technology-framework

ONS: Research and Development Expenditure
www.ons.gov.uk/economy/governmentpublicsectorandtaxes/researchanddevelopmentexpenditure

ONS: Regional UK business research and development, methods
www.ons.gov.uk/businessindustryandtrade/business/businessinnovation/methodologies/regionalukbusinessresearchanddevelopmentmethods

VIEWPOINT

A study led by Lord William Hague and Sir Tony Blair is calling for a radical change in the focus of the machinery of government, one where science and technology are placed right at the centre.

Re-imagining the state

Benedict Macon-Cooney

The UK has continually been at the forefront of great scientific and technological breakthroughs, a record of which we should rightly be proud.

But as we enter a new technological era and AI develops at pace, humans and machine will together determine the next wave of our endeavour. If the UK is to once more shape the future, we need to completely reimagine the state and how it delivers for its citizens.

This was the starting point of a series of so far three New National Purpose reports from the Institute for Global Change, co-led by Lord William Hague and Sir Tony Blair. In the first[1], we set out a programme for how the machinery of government can reorient to centre around science and tech, by:

- reorganising the centre of government, with the full weight of the Prime Minister's authority behind it;
- building foundational AI-era infrastructure, including a national health infrastructure that brings together interoperable data platforms and treats data as a competitive asset;
- creating an Advanced Procurement Agency, incentivising pensions consolidation and encouraging growth equity;
- reforming technology transfer offices to encourage more university spinouts, increasing R&D investment and reforming the way science, research and innovation institutions are funded and regulated;
- investing in new models of organising science and technology research, expanding the Advanced Research and Invention Agency and creating innovative laboratories that seed new industries;
- pursuing broader planning reforms, mainstreaming new technologies in education;
- building stronger global partnerships.

Agile

Achieving all of this requires the state to be far more agile in adapting to the technological developments that are going to increase in pace in the coming months and years.

We argue the Government needs to address the issue of talent and expertise – attracting and incentivising more engineers, scientists and technologists in Government – and refocus on how it develops, procures and adopts technology. The private sector is already moving at pace to utilise AI, inventing new ideas and reinventing business models in the process. The opportunity is going begging for Government.

Pushing the frontiers of science and technology will drive economic growth across the economy, in manufacturing and materials science, clean technology and cybersecurity to give just a few examples. Our industrial strategy is AI.

Biotech and healthcare

This is particularly important for biotech[2]. It is an area of science and technology whose historical track record is one of our great successes: penicillin, the discovery of DNA and the invention of molecular biology.

Done well, biotech can be another building block in a reimagined state that improves and extends lives, hosts the companies of the future and sets the UK up for a century of success. The UK's speculative MRC Laboratory of Molecular Biology in 1962 drew generations of the world's most sought-after talent to Cambridge, resulting in 12 Nobel Prizes to date. The Cambridge Biomedical Campus boosted the UK economy by £2.2 billion in gross value added in 2021 alone.

However, the world of frontier research is changing, and as others move at pace, the UK needs to ambitiously embrace opportunities across a host of fields. We need a new laboratory, the Laboratory of Biodesign, focussed on the invention of biotechnology that is currently at too early a stage for commercial investors and companies. This would use experimental and computational methods to design, build and test new biotechnologies, biomolecules and therapeutics under one roof.

Importantly, it would pioneer a new institutional model[3]. This model, in the form of interdis-

Benedict Macon-Cooney is the Chief Policy Strategist at the Tony Blair Institute for Global Change. He is an expert in economic and technology policy, with a special emphasis on artificial intelligence, biotech and clean tech. Benedict has advised foreign governments in his work at TBI and has previously worked for HM Treasury on its response to the 2008 global financial crisis.

The world of frontier research is changing, and as others move at pace, the UK needs to ambitiously embrace opportunities across a host of fields.


CAMBRIDGE BIOMEDICAL CAMPUS

The Cambridge Biomedical Campus boosted the UK economy by £2.2 billion in gross value added in 2021 alone.

ciplinary Disruption Innovation Labs for focussed areas of research, would not rely on principal investigators employing teams of graduate students and postdocs. Applying lessons from Bell Labs, Xerox PARC, Google DeepMind and Gerry Rubin's Janelia Research Campus, which all share common features that differ markedly from conventional research environments, the network of Labs should work at the intersection of AI and 15 different disciplines, be benchmarked to leading international competitors in core funding and bring together a critical concentration of researchers across science and engineering. They would become an essential component of AI-era industrial strategy, training the next generation of talent, spinning out promising startups, and producing output that will accelerate research and growth.

The NHS

The NHS would have a vital role to play. Part of this will be through better procurement, to ensure that our health and care sector is adopting and stimulating innovation in science. But alongside new personal healthcare accounts where each of us own and control our data, we suggest another way to open up research and innovation from biomedical data as a new NHS Data Trust. Majority-owned and controlled by the NHS in collaboration with trusted external partners, the NHSDT would treat NHS data as a competitive asset. Using this national asset imaginatively will save lives, improve care, and realise significant commercial value for the benefit of the public.

This would include establishing a central platform with a single front door for accessing anonymised data, primarily at a national scale, to both commercial and non-profit research entities, which would include large companies. In return, the NHS will benefit from hypothecated investment from the financial profit, and enhanced access and affordability to advanced treatments developed from the data provided. A tiered pricing model will enable equitable data access for UK-based small and medium enterprises, charities, and academic institutions, thereby nurturing homegrown invention capabilities.

A transparent governance model that puts the public at the centre would ensure that our data remain safe and secure, and that NHSDT's operations strongly align with public-health objectives. This has the potential to raise significant amounts of capital at a time when funding the NHS is increasingly difficult. It is a radical, but practical new model to invest in our health.

If we are to lead the biotech revolution, research and biomedical data will provide the foundation. And core to this is building companies and products to improve human health.

As it stands, the most vibrant biotechnology cluster in the world is Boston in the US. Around Kendall Square companies such as Biogen, Eli Lilly and Moderna are some of the 250 plus companies driving developments in the human experience. More broadly, the US is responsible for more than half of the global market cap of $6 trillion.

The UK has had many notable successes, and today is home to companies such as AstraZeneca, Exscientia, Centessa Pharmaceuticals and Immunocore. The opportunity the UK presents has also meant that companies and investors such as Recursion and Flagship have set up here. But the UK is a major exporter of technology, and the US a key beneficiary.

Scaling up

We need to shift the balance and set our sights on emerging lights such as Isomorphic Labs becoming trillion-dollar companies that scale in the UK and list on the London Stock Exchange. This will require a mindset shift, fostering a more vibrant ecosystem and expertise in which emerging managers, solo general partners and operators running funds can increase the competitiveness and depth of capital in the UK, setting spinout terms that incentivise and reward entrepreneurs, as well as reforming pension funds and our capital markets. Specifically, we recommend:

- incentivising pensions consolidation and encouraging growth equity by changing pension capital-gains tax exemption and combining the UK Pension Protection Fund and the National Employment Savings Trust to create a single investment vehicle that participates in market consolidation;
- British Business Bank should set up a programmatic follow-on fund that invests in UK companies that have their Series A or B round led by a Tier 1 firm. Firms would make

more money this way and provide a valuable product to small managers in the UK who do not have the capacity for pro-rata follow-up funding. Crucially, this fund should not be used to prop up Series B+ companies that struggle to raise capital – it should be used for supercharging proto-winners that have a chance of returning capital to the taxpayer;
- setting up a real emerging-manager anchor programme, where a large investor commits significant capital to support the growth of new, often smaller investment firms. This should be a quick process, with no more than six months to secure 20% of a fund;
- creating a sandbox that allows small managers to launch and run without the same overheads as the big funds. Areas such as Anti-Money Laundering and Know Your Customer should still be kept but removing other requirements would present a significant opportunity to attract managers across Europe to base themselves in the UK.

Britain has a chance to capitalise on this next wave of innovation. From putting the conditions in place to make Britain home to the companies and inventions that will help people live healthier, longer lives, to opening up economic opportunity and growth, to protecting the world by creating biosecure societies. For those that have become pessimistic about the state of our nation, this might seem unimaginable. But with science and technology at the heart of our Government, we can reimagine what is possible. □

With science and technology at the heart of our Government, we can reimagine what is possible.

DOI: 10.53289/KSDL2852

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2. www.institute.global/insights/politics-and-governance/a-new-national-purpose-leading-the-biotech-revolution
3. www.institute.global/insights/politics-and-governance/new-national-purpose-ai-promises-world-leading-future-of-britain

OBITUARY: SIR GEOFFREY CHIPPERFIELD KCB

20 April 1933 – 30 January 2024

After a highly successful career as a civil servant, rising to the rank of Permanent Secretary, Geoffrey Chipperfield built a second career in which he put to the service of commerce, science and academia the wide experience and knowledge acquired during his years of service to Governments of differing political complexions.

Geoffrey Chipperfield was educated at Cranleigh and New College Oxford. After leaving Oxford he was called to the Bar at Gray's Inn in 1955. In 1956 he entered the Administrative Class of the Civil Service in the then Ministry of Housing and Local Government. He rose rapidly through the ranks of that Department, becoming a Deputy Secretary in 1982, having served in a variety of posts, including Principal Private Secretary to the Minister of Housing and Secretary of the Greater London Development Plan Inquiry (1970 to 1973).

In 1987, as a Deputy Secretary, he moved to the Department of Energy. After no more than two years facing totally new and even more challenging responsibilities (not least dealing with the aftermath of the Piper Alpha North Sea oil rig disaster of 1988) he became the Permanent Secretary of that Department. Fresh challenges awaited him only two years later when he was moved to the Property Services Agency, steering that organisation which looked after the Government's real estate, from public ownership into the private sector.

Sir Geoffrey Chipperfield: a quintessential Permanent Secretary.

The compulsory retirement of civil servants at the age of 60 meant that his administrative and managerial talents became available for use in many other walks of life. Among the most significant were Higher Education and Science. In 1998 he was appointed Pro-Chancellor of Kent University, serving with such distinction that a building there now carries his name. In 2003 he joined the Council of the Foundation for Science and Technology and remained in that position until 2016. During that time he performed the important task of compiling the reports of the Foundation's dinner-discussions, ensuring that the views of those present were conveyed in a coherent and authoritative way to Government and society at large. Geoffrey Chipperfield's skills as a civil servant proved well-tailored to the needs of clear and persuasive communication between scientists and policy makers. He also served as a non-executive director, and subsequently Deputy Chairman, of South West Water.

Geoffrey Chipperfield was awarded the CB in 1985 and appointed KCB in 1992. He was a keen walker, gardener and supporter of the arts and music. He died after a long illness and is survived by his wife Gillian whom he married in 1959.

Sir John Caines KCB

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Can Artificial Intelligence be regulated and if so how?
28 February 2024

Stephen Almond, Executive Director, Regulatory Risk, Information Commissioner's Office
Professor Sana Khareghani, Professor of AI Practice, Kings College London
Dr Cosmina Dorobantu, Co-Director and Policy Fellow,, Public Policy Programme, The Alan Turing Institute
Professor Dame Wendy Hall DBE FRS FREng, Regius Professor of Computer Science, University of Southampton
John Gibson, Chief Commercial Officer, Faculty AI

Scaling up deep technology companies in the UK – challenges and solutions
24 January 2024

Amelia Armour, Partner, Early Stage Funds, Amadeus Capital Partners
Dr Simon Thomas FREng, Chief Executive Officer, Paragraf
Scott O'Brien, Chief Investment Officer, Innovate UK, UKRI
Gus Wiseman, Deputy Director, Head of Investor Relations, Department for Business and Trade

A Round Table on Artificial Intelligence
16 January 2024

Horizon Europe – making UK participation a success
6 December 2023

George Freeman MP, Former Minister for Science, Research and Innovation
Professor Maria Leptin, President, European Research Council
Professor Christopher Smith, Executive Chair of AHRC and UKRI International Champion
Professor Mary Ryan, Vice Provost (Research and Enterprise), Imperial College London

Risk and Resilience - Foundation Future Leaders Conference 2023
20 November 2023

Inventing a Better Britain - How does R&D fit into a new UK economic strategy?
November 15, 2023

Professor Dame Ottoline Leyser DBE FRS, Chief Executive , UKRI
Grant Fitzner, Chief Economist, Office for National Statistics
Professor Jonathan Haskel, Professor of Economics, Imperial College

Net Zero - UK and global progress
October 11, 2023

Lord Deben, Former Chair, Climate Change Committee
Professor Paul Monks, Chief Scientific Adviser, Department of Energy Security and Net Zero
Baroness Brown of Cambridge DBE FREng FRS, Chair of the Adaptation Committee, Committee on Climate Change and Chair, House of Lord Science and Technology Committee
Professor Jim Skea CBE, Chair, Intergovernmental Panel on Climate Change

Transforming Scottish Healthcare – The Role of Data and Technology
October 5, 2023

Professor Sarah Curtis FRSE, Honorary Professor, University of Edinburgh
Jonathan Cameron, Deputy Director of Digital Health and Care, Scottish Govt.
Professor Patricia Connolly, Deputy Associate Principal, Biomedical Engineering, University of Strathclyde
Professor Oliver Lemon, Co-academic lead, National Robotarium
Dr Ken Sutherland FRSE, President, Canon Medical Research Europe

The Emerging Shape of REF 2028
July 5, 2023

Professor Geraint Rees FMedSci, Vice-Provost for Research, Innovation and Global Engagement, University College London
The Rt Hon the Lord Willetts, Chair, The Foundation for Science and Technology
Dame Jessica Corner, Executive Chair, Research England
Dr Steven Hill, Director of Research, Research England
Sir Peter Gluckman, Chair FRAP IAG and President, International Science Council
Dr Elizabeth Gadd, Vice-Chair, CoARA and Loughborough University
Professor James Wilsdon, Director, Research on Research Institute, University College London
Professor Louise Bracken, PVC for Research & Knowledge Exchange, Northumbria University
Diego Baptista, Head of Research Funding & Equity, Wellcome Trust
Professor Simon Hettrick, University of Southampton and Chair, The Hidden REF
Emma Todd, Director of Research Culture, University College London

Equity, Diversity and Inclusion in STEM
June 28, 2023

Dr Lilian Hunt, Equality, Diversity & Inclusion in Science and Health (EDIS) Lead, Wellcome Trust
Rachel Lambert-Forsyth, Chief Executive, British Pharmacological Society & Science Council Trustee
Kevin Coutinho, Pro-Director: Equality, Diversity and Inclusion, London School of Hygiene and Tropical Medicine & British Science Association Trustee

The use of AI in the early detection of disease
June 14, 2023

David Crosby, Head of Early Detection Research, Cancer Research UK
Mike Oldham, Director of Early Detection of Neurodegenerative Diseases, Alzheimer's Research UK
Jessica Morley, Oxford Internet Institute, University of Oxford
Tobias Rijken, Co-Founder and Chief Technology Officer, Kheiron Medical Technologies

The UK Semiconductor Strategy
May 24, 2023

Paul Scully MP, Minister for Tech and the Digital Economy, Department for Science, Innovation & Technology
Dr Andy Sellars, Strategic Development Director, Compound Semiconductor Applications Catapult
David Clark, Chief Technology Officer, Clas-SiC Wafer Fab
Dr Jalal Bagherli, Former CEO, Dialog Semiconductor

The Nurse Review of the Research, Development & Innovation Landscape
May 15, 2023

Sir Paul Nurse FRS FMedSci, Chair, the Research, Development & Innovation Landscape Review
Chi Onwurah MP, Labour Shadow Minister for Science, Research & Innovation
Dr Peter Thompson FREng FInstP FRSC CEng, Chief Executive, National Physical Laboratory
Vivienne Stern MBE, Chief Executive, Universities UK

In conversation with Sir Patrick Vallance
26 April 2023

Sir Patrick Vallance KCB FRS FMedSci, Outgoing Government Chief Scientific Adviser
The Rt Hon the Lord Willetts FRS HonFREng, Chairman, The Foundation for Science and Technology

MAJOR SUPPORTERS IN 2024/2025

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Arts and Humanities Research Council, UKRI
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B

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C

Canterbury Christ Church University
Chartered Institute of Credit Management
Comino Foundation
Cranfield University

D

Defence and Security Accelerator
Defence Science and Technology Laboratory
Department of Health and Social Care

E

Economic and Social Research Council, UKRI
EIB Institute
Elsevier b.v.
Engineering and Physical Sciences Research Council, UKRI
ERA Foundation

G

Genomics England

H

Haskel Family Foundation
Heads of University Centres of Biomedical Science (HUCBMS)
Health and Safety Executive
High Value Manufacturing Catapult

I

Imperial College London
Innovate UK, UKRI
Institute of Biomedical Science
Institute of Materials, Minerals & Mining
Institute of Mathematics and its Applications
Institute of Quarrying
Institution of Chemical Engineers
Institution of Mechanical Engineers
Institution of Railway Operators

J

Japan Society for the Promotion of Science

K

Kaizen UK Consulting Ltd (Kaizen Institute)
King's College London

L

Lancaster University

M

Matrix - The Northern Ireland Science Industry Panel
Medical Research Council, UKRI
Met Office

N

National Centre for Universities and Business
National Physical Laboratory
Natural Environment Research Council, UKRI
Natural History Museum
Nottingham Trent University

P

Parliamentary and Scientific Committee
Peter Jost Charitable Foundation

R

Research England, UKRI
Rolls-Royce
Royal Society of Biology
Royal Society of Chemistry
Royal Statistical Society

S

Science and Technology Facilities Council, UKRI
Society of Maritime Studies
Society of Operations Engineers

T

The Academy of Medical Sciences
The Royal Academy of Engineering
The Royal Commission for the Exhibition of 1851
The Royal Society

U

University College London
University of Bath, Institute for Policy Research
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