Creating an impact

Celebrating scientists working for a better future

THE ROYAL SOCIETY

Contents

Sir Adrian Smith
President of the Royal Society

"Innovation is the lifeblood of our economy and a key driver for improving lives."

Innovation is the lifeblood of our economy and a key driver for improving lives. Entrepreneurs are improving diagnostics, developing new medicines and helping life-saving treatments reach more people. They are using modelling and quantum computing to develop newer, greener technologies. They are creating higher yield crops to feed more people, greening industrial processes and helping to reduce the impact of flooding. And those are just the stories of people you can read about in the pages of this document. The stories of people supported by the Royal Society.

Our tech sector is worth over $1 trillion, the largest in Europe, with 2023 being a record year for tech start-ups in the UK. We have world leading universities and research institutes and also have the most investment in university spinouts in Europe. More can be done to support those companies to grow, but we have a great base to build from.

That base goes much deeper than great translation. Innovation is built upon decades of basic research and we need a full range of support for science. As George Porter, a predecessor as President of the Royal Society, said "To feed applied science by starving basic science is like economizing on the foundations of a building so that it may be built higher. It is only a matter of time before the whole edifice crumbles."

At the Royal Society, as well as feeding basic science, we are working to support a culture of entrepreneurship, promoting collaboration between industry and academia and encouraging those who want to start and grow companies. We are supporting people who want to develop innovative technology, translate their research into commercial products and break down barriers that hinder their progress. The people we are celebrating in these pages tell that better than I can. I hope you enjoy reading their stories and are inspired to play your own part in supporting the innovation journey from our labs, to our factories and businesses, and into people's lives.

Dr Fiona Marshall FRS

Royal Society Fellow (elected 2021)

Dr Fiona Marshall was elected a Fellow of the Royal Society in recognition of her impact in biomedical research. She is currently President of Biomedical Research at Novartis where she leads over five thousand scientists, each of whom are contributing to the discovery of novel medicines to treat a range of diseases. Having had the desire to discover something new since her schooldays, and after her PhD at the University of Cambridge was sponsored by industry, Fiona's career naturally led into the biotechnology and pharmaceutical sectors.

Fiona co-founded Heptares Therapeutics in 2006, a start-up from the MRC Laboratory of Molecular Biology exploiting the early science emerging from the purification and stabilisation of membrane proteins for structure determination, which could be used to discover novel drug candidates. She grew the company under her role as Chief Scientific Officer, adapting the science to a commercial basis and publishing structures of proteins which had never been solved before. The company was acquired by Sosei Group in 2015 and continues to operate in Cambridge. To this day, Fiona regards building the company as one of her greatest achievements.

Already having pre-existing connections with the Royal Society through working as a member of the Science, Industry and Translation Committee, Fiona was delighted to discover she had been elected as a Fellow. Upon her election she recognised that the FRS postnominals are valued in both academia and industry, with the Society being respected as an independent voice of reason across the world. She continues to work on various committees and projects in partnership with the Society.

Her work in the pharmaceutical sector has had a significant impact on the lives of patients, ameliorating disease and increasing healthy lifespan. She has also made an impact economically through supporting the many researchers and companies that contribute to the healthcare industry environment. Fiona is proud that her career shows it is possible to take a career break to have a family, whilst continuing to work at the highest level in industry and being recognised for excellence in science.

"The Royal Society raises the profile of scientific research happening in industry. It shows academics that working in industry is a force for good."

Professor Paul Bates CBE FRS

Royal Society Fellow (elected 2021)

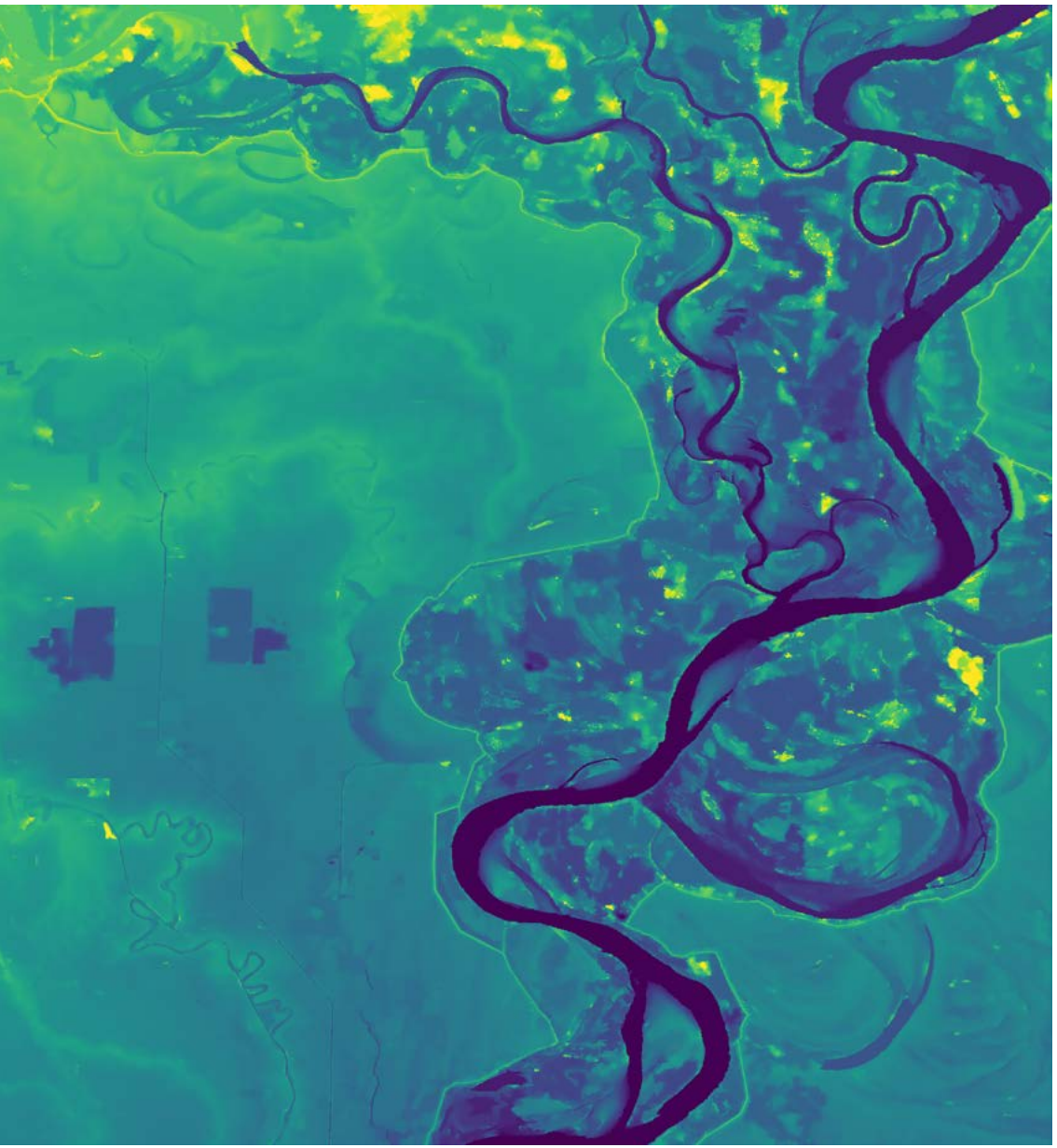
Paul Bates is Professor of Hydrology at the University of Bristol. He specialises in the science of flooding and was awarded a CBE in 2019 for services to flood risk management. In 2013 he co-founded Fathom, a world-leading flood and climate risk firm based in Bristol, reducing threats to life and economic losses worldwide. In 2021 he was elected as a Fellow of the Royal Society.

During his undergraduate degree, Paul became fascinated by the idea of simulating the environment using computer models and went on to study a PhD in flood inundation modelling. At the time, flood risk was not a popular research area and there was little social or academic interest in the topic. A few years after completing his PhD, the UK was affected by a series of large floods which created multiple new datasets. This wealth of new data, combined with the emergence of airborne LiDAR technology for terrain mapping, allowed the research to progress significantly.

The models are based on Newtonian physics and simulate the movement of water over the land surface. When combined with satellite and airborne data, it is possible to identify the areas that are most of risk of flooding. Due to lack of data in other countries, the modelling was initially only possible in the UK and other developed countries, such as the Netherlands. However, improved satellite technology has given Paul access to global datasets to build models for countries across the world. It became clear there was a commercial possibility for the research, and in 2013 two of Paul's PhD students approached him with the idea of starting a company. Fathom was founded with an initial four co-founders and now has over fifty employees.

Millions of people across the world are affected by flooding each year. Climate change is increasing the frequency of floods, with Fathom's models predicting that the annual damage caused by flooding in Britain could increase by more than a fifth over the next century. Having the ability to understand the areas most at risk of flooding is crucial, as it enables informed decision making over flood defence structures and moving communities out of danger.

Fathom now works with a range of institutions across the globe, including small organisations, government agencies and multinational corporations. In December 2023 they became a subsidiary of Swiss Re, one of the world's leading providers of reinsurance and insurance.



"In my world, there's no barrier between commercial science and academic science. A virtuous circle exists between them both."

Left:
A section of the Mississippi River modelled in Fathom's digital elevation model, FABDEM+.

Dr Asel Sartbaeva

University Research Fellow (2011 – 2019)

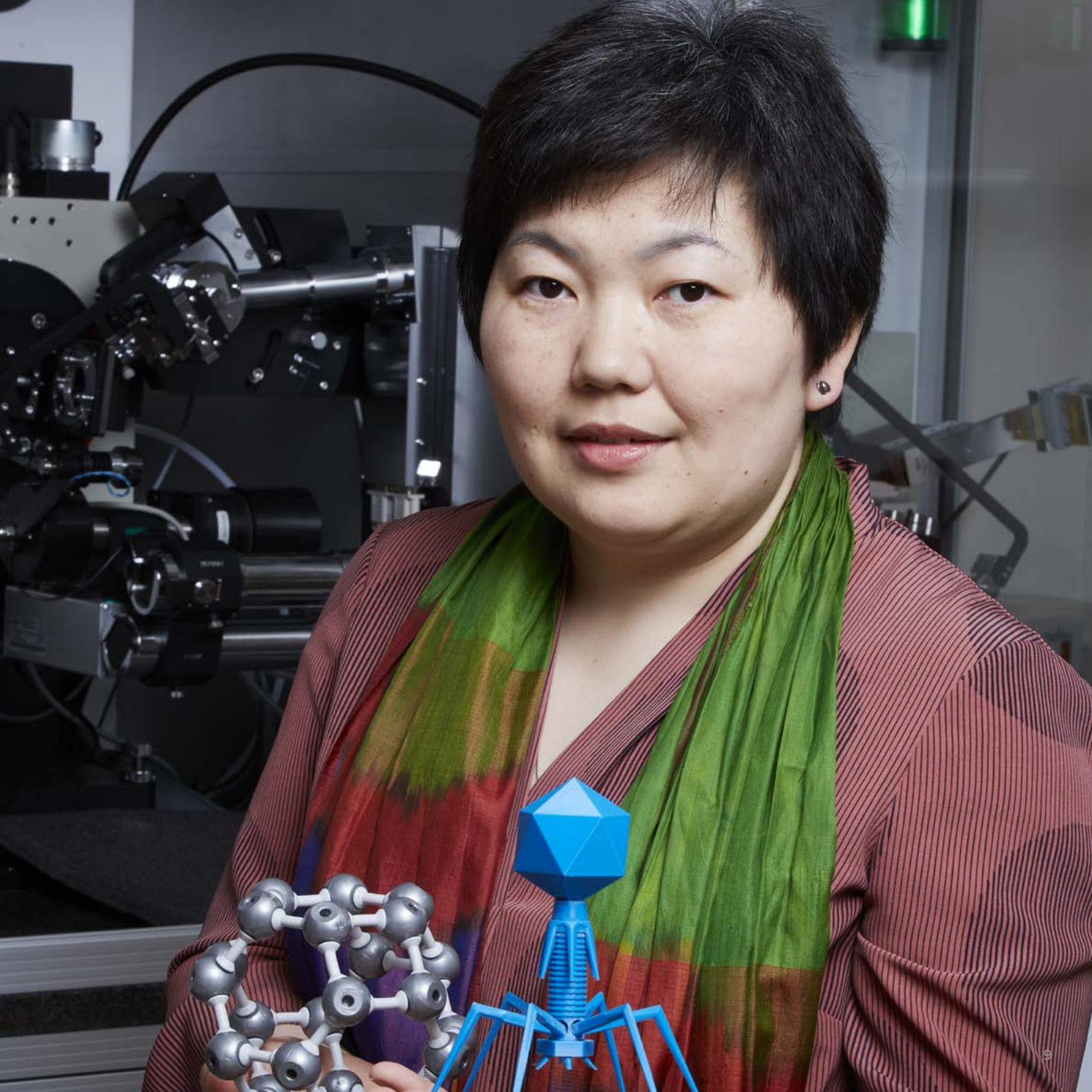
Educated in Kyrgyzstan, Dr Asel Sartbaeva moved to the UK to study a PhD in physical sciences. She specialised in zeolites, crystalline aluminosilicate materials commonly used as adsorbents and catalysts, before being awarded a University Research Fellowship in 2010 to study silica-based materials at the University of Oxford. Asel is now CEO of her own business, EnsiliTech, developing groundbreaking technology to remove the need for refrigeration of essential vaccines.

The Fellowship allowed flexibility for Asel to explore side projects, one of which emerged after taking her daughter to be vaccinated. She observed how vaccines had to be stored in fridges to prevent degradation, and later discovered that approximately half of the vaccines spoil due to cold chain failures. Further investigation revealed how 1.5 million infants are dying prematurely every year from vaccine preventable diseases. Asel questioned if her knowledge of silica-based materials could be used to build a way to protect the biological molecules in vaccines from the effects of temperature.

Asel moved her Fellowship to the University of Bath to initiate key collaborations and continued to develop the technology. Now established, the technology can shrink wrap vaccine components in a protective layer of silica, preventing them from degrading until point of use when the silica can then be removed and metabolised naturally by the body. The need for a cold chain of transport has been obviated, increasing the accessibility of biological therapeutics and diagnostics globally. The technology has the ability to cover a wide variety of vaccine types, including the mRNA vaccines developed for the coronavirus, and has the potential to be delivered in tablet form in the future.

Asel decided to form a spin-out after drawing courage from several of the courses on commercialisation available to all University Research Fellows. The technology eventually came to the attention of investors, and in 2022 the company, EnsiliTech, officially span out from the University of Bath.
The company is now based in Bristol and has 12 employees, with Asel as CEO. They already have their first customer and are hoping to expand to multiple vaccines in the long term.

> "The URF's flexibility allowed me to pursue alternative research ideas outside of my fellowship. Without the Royal Society there would be no Ensilitech."



Dr Toby Cubitt

University Research Fellow (2013 – 2022)

Dr Toby Cubitt is a mathematical physicist and Professor of Quantum Information at University College London (UCL). He undertook a University Research Fellowship between 2013 and 2022, starting at the University of Cambridge before moving to UCL. He now divides his time between academia and serving as the Chief Technology Officer and Chief Science Officer of his company, Phasecraft, a quantum algorithms spinout.

Toby was motivated to start a business developing quantum algorithms from the realisation that there was an opportunity for theorists to play a significant role in building this new technology, and few were doing so. Possessing both the interest and capability to pioneer the underlying algorithms essential to make quantum computing a practical reality, Toby co-founded Phasecraft with academics from the University of Bristol and UCL in 2019.

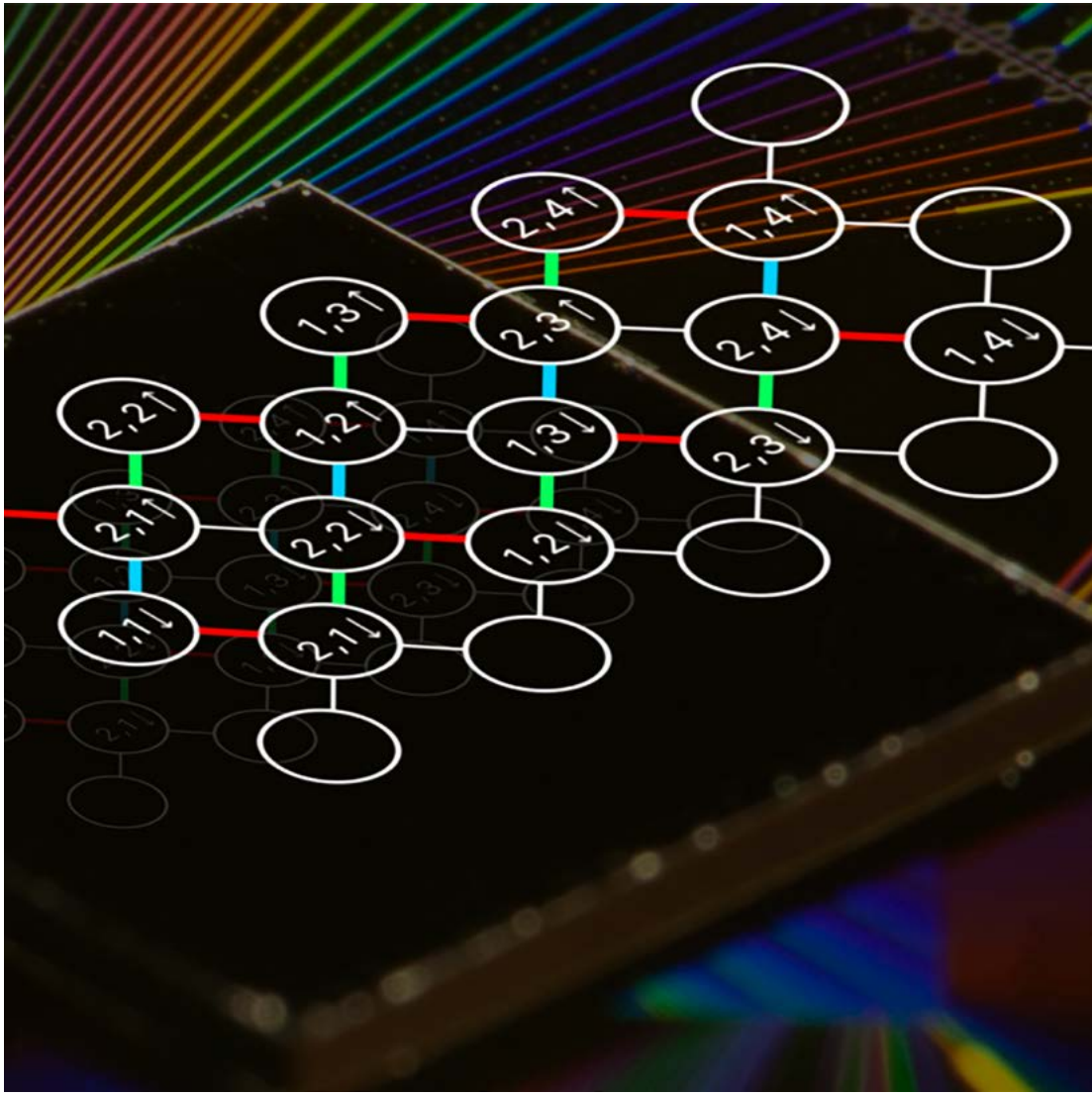
Although quantum computing could revolutionise the way humanity tackles complex challenges, the current hardware that exists isn't capable of running the algorithms needed to solve them. Phasecraft have already developed significantly more efficient quantum algorithms to be used on near-term quantum computers and are focusing their research on getting real-world applications onto early-stage quantum hardware. They are currently applying quantum computing to simulate materials science, with the results potentially leading to more efficient batteries, photovoltaics, supercapacitors and fuel cells, all of which are crucial in powering the clean energy transition.

The flexibility of the University Research Fellowship allowed Toby to allocate time from his fellowship to co-found Phasecraft, whilst simultaneously navigating the steep learning curve required to run a successful spin-out. Transitioning from academia, where risk is carefully framed within funding proposals, it was initially challenging for Toby to work alongside an inverted risk profile in venture capital, where investors are attracted to high-risk, high reward strategies. The team are now collaborating with industry giants like Google and IBM, having also garnered attention from Silicon Valley investors.

Phasecraft has the potential to revolutionise the world of computing, and its founders believe that running a useful application on a quantum computer could be achievable within the next three years.

"[The University Research Fellowship] allowed me the flexibility to pursue the development of Phasecraft whilst still progressing my fundamental academic research."

Right:
Representation of the qubit layout for implementing the 2x4 instance of the Fermi-Hubbard model on Google hardware. © James Crawford / Google Quantum AI.



Professor Steven Kelly

University Research Fellow (2014 – 2023)

Originally from Ireland, Professor Kelly moved to England to study a DPhil at the University of Oxford. Wanting a career that had real world impact, Steven initially studied infectious human disease before switching fields to become Professor of Plant Sciences at the University of Oxford. He is also co-founder of Wild Bioscience, a spinout from the University of Oxford developing high-yielding, climate-resilient crop varieties.

The expansion of agriculture to feed an increasing human population has pushed the biosphere beyond the planetary boundary. Steven realised that the key solution to this problem was to reduce the amount of land used for agriculture and started to determine how to get important food crops to make more food, whilst simultaneously reducing their requirement for land, fertilizers, and water. Whilst undergoing his University Research Fellowship, Steven discovered it was possible to make plants grow faster and produce more seeds using fewer resources. Through precision breeding techniques, he also found that by using naturally evolved improvements to photosynthesis found in wild plants, the yield of crops, such as wheat or rice, could be improved.

Taking maize as an example, Steven and his lab have identified a gene which helps the plant carry out efficient C4 photosynthesis. Using molecular and computational biology, the team have harnessed the same gene in wheat and soybean, allowing the crops to grow faster and require fewer resources.

Steven's unique approach uses artificial intelligence and machine learning to identify the genes that nature used to improve photosynthetic pathways and determine how to introduce them into our food crops using precision breeding.

In 2021, Steven co-founded Wild Bioscience based on the research from his University Research Fellowship. Despite having no prior experience of research commercialisation and undergoing a steep learning curve, the company has grown to 25 full-time staff. As well as improving crop yield, the company is also trying to combat climate change by breeding plants that can remove carbon dioxide from the atmosphere and sequester it for long term storage in the soil. These climate change fighting plants are currently undergoing field trials across the globe, with promising initial results.

The company has been successful in raising private and public funding, and the team are currently planning Series A funding for later in 2024.

"The freedom and length of the URF allowed me to tackle really challenging areas of research. I was able to explore multiple different ideas, take on big projects, and deliver several proofs of concept that demonstrate the potential societal and economic value of the research."

Dr Kyra Sedransk Campbell
Dorothy Hodgkin Research Fellowship (2016 – 2020)

Dr Campbell undertook the Dorothy Hodgkin Research Fellowship at Imperial College London in the Department of Chemical Engineering. Interested in reactions in ionic liquids and how they engage with surfaces and materials, Kyra develops techniques and models to describe phenomena from a fundamental standpoint, tackling the problems facing the water industry.

Having recently returned from maternity leave, Kyra was looking for a grant which could accommodate her childcare responsibilities. Her initial application was accepted on the proposal of a technique development method to study an electrochemical system phenomenon. However, as the Fellowship progressed, she discovered alternative interesting areas of research and the Fellowship allowed her to explore these in more detail despite not being part of the original proposal.

Over the four-year grant, Kyra was exposed to various industrial organisations which were facing problems such as scaling, fouling and corrosion. Companies were also having to alter their existing chemical usage as emerging research was uncovering previously unknown environmental harms. This exposure led Kyra to question how her work was making a difference to society, and a realisation that partnering with industry can allow for faster problem solving.

Kyra co-founded Nanomox in 2020 after creating a platform of metal oxides with two unique attributes: the process uses ionic liquids which are sustainable and can create a controlled crystal morphology without using energy-intensive, expensive techniques. The technology was initially used to create cheaper and more sustainable suncream as it allowed greener production of zinc oxide. After receiving further investment and funding, Kyra stepped away from the company, although it continues to grow.

Kyra is now at the University of Sheffield and is focusing on building her next endeavour formulating sustainable green additives, as well as developing a technology that allows the recycling of material waste streams.

> "Commercialisation provides the most efficient way to reach customers who need help. It's not about the money. It's about solving industrial problems that help the environment and using the funding to solve the next set of problems that emerge."

Professor Rebecca Goss

Royal Society Dorothy Hodgkin Research Fellow (2003 – 2007) and Royal Society Industry Fellow (2021 – 2023)

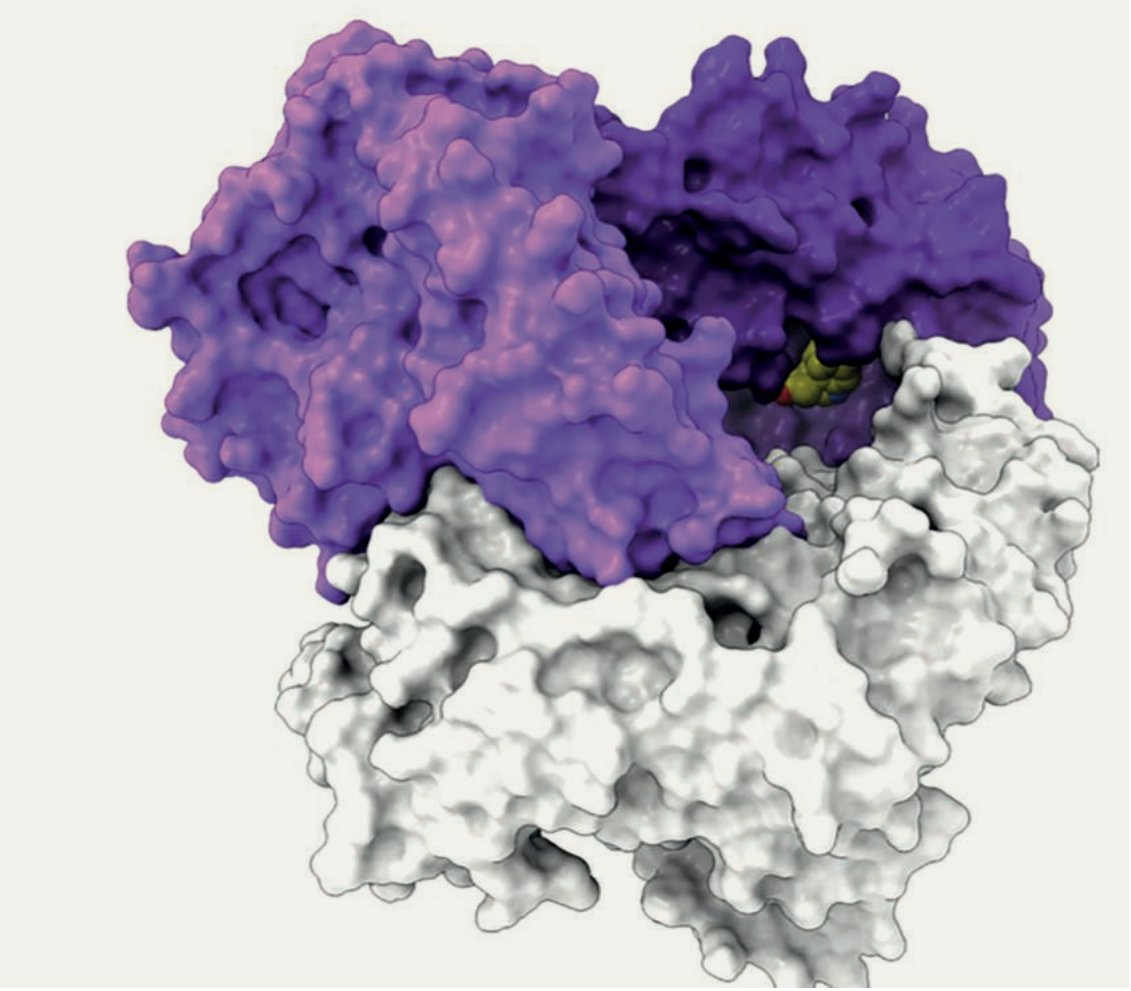
Professor Goss is Professor of Biomolecular and Organic Chemistry at the University of St Andrews, with research interests in the biosynthesis of medicinally relevant natural products at the chemical and genetic level. Rebecca is also CEO and Founder of X-Genix, a spin-out from St Andrews University which offers a disruptive platform technology for accelerating drug discovery.

Chemists have traditionally been unable to perform precision molecule editing as it is extremely difficult to bond to a defined position in an organic molecule. Consequently, the modifications made to produce compounds for early drug discovery programmes are often selected for ease of synthesis, rather than their potential to be the most active in drug screening assays. Whilst tools for precision molecule editing of small molecules are elusive, this challenge is exacerbated for larger, more chemically sophisticated molecules. It is particularly challenging for natural products which often have highly intricate scaffolds.

Using early ideas from her Dorothy Hodgkin Fellowship, Rebecca has developed a set of enzymatic tools which can be used to accelerate drug discovery. The process uses naturally occurring enzymes to enable precise targeting of one atom in a molecular structure so that it can be further modified chemically with a diverse range of additions. The key to the process is to form a carbon halogen bond, with a high level of control and selectivity, precisely at the molecular site of interest. Once installed, this chemically reactive carbon halogen provides a direct gateway for almost any chemical diversification imaginable.

Rebecca founded X-Genix in early 2021 after realising the potential of the technology. Using this new set of tools, chemists can design new variants of the original molecule to test if they have the predicted properties at a small scale, before embarking on a larger project. This will allow companies to improve the efficiency of their drug development processes by reducing both the cost and time involved.

Rebecca applied for the Industry Fellowship award in 2020. The grant allowed her to spend time developing X-Genix's technology, whilst also having the opportunity to meet with a large number of pharmaceutical companies to see how the technology could be applied in their businesses. The company is now focusing on securing the next round of investment, with the long-term goal of accelerating drug discovery across the pharmaceutical industry.



"The Industry Fellowship allowed me to spend the time I needed on developing the technology for the spinout; there's so many stacks of plates that you're spinning at any one time, having the time to focus on one alone is critical."

Left:
VirX1, the first halogenase to be characterised from a virus, and powerful tool for precision C-X bond formation.

Professor Stephen Jarvis

Royal Society Industry Fellow (2009 – 2013)

Professor Jarvis has spent his career predominantly in academia focusing on engineering and computer science. Before joining the University of Birmingham, Stephen worked at the University of Warwick where he undertook an Industry Fellowship in partnership with Rolls-Royce.

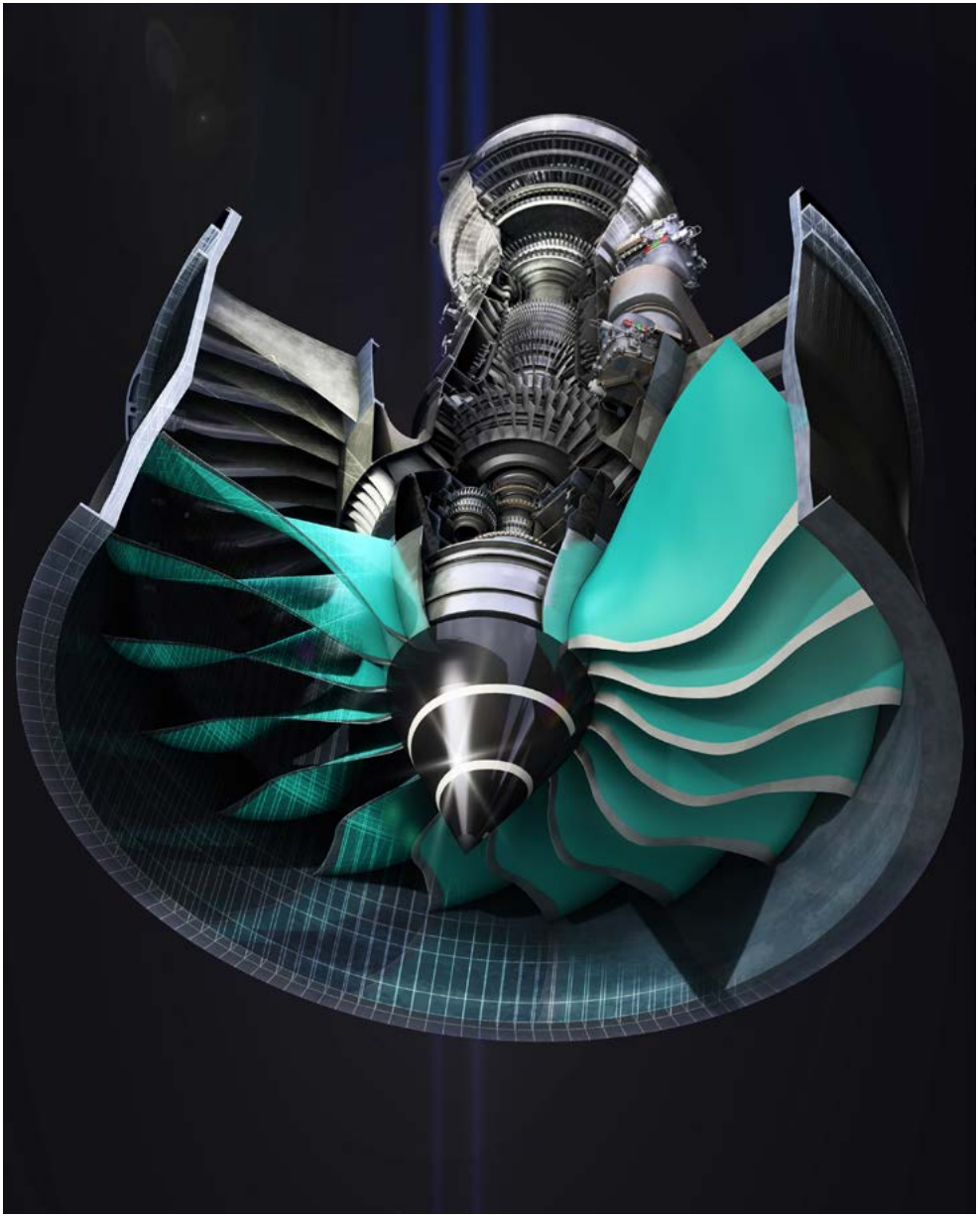
Stephen's application for an Industry Fellowship was inspired by a chance encounter with an existing Rolls-Royce Industry Fellow who suggested he apply for the scheme. He already possessed the knowledge and understanding that certain computer software applications worked more efficiently on selected hardware designs, which was of great interest to Rolls-Royce who invested a significant amount of money on computers and wanted the best results.

Stephen's Industry Fellow project was on the simulation of turbofan jet engines design. In the past, refining the design of these complex engines was expensive and took several years as it required making physical models and incorporating physical modifications. The aim of Stephen's project was to accelerate the development of accurate digital models. Using the models, it would be possible to find novel design modifications to respond to demands for greener, quieter, and more sustainable jet engines. Various options for aviation propulsion in the future, such as fully electric, hydrogen powered, or hybrid jet engines, will rely on the use of ultra-accurate simulations. Without them, the cost of development would be prohibitive and not rapid enough to meet today's sustainability goals.

Taking the Industry Fellowship part-time allowed Stephen to split his time between the university labs whilst becoming embedded within the Rolls-Royce engineering design team in Derby. This experienced shaped the rest of his career, as he continues to work with Rolls-Royce to this day. It also changed the way he interprets science within the university context, with Stephen now always considering what practical application and deployment could be made. Stephen continued to have research projects with Rolls-Royce for years after the Industry Fellowship, allowing him, students and postdocs to move between the lab in Derby and the lab at the University of Warwick.

Stephen is now part of the Prosperity Partnership for Advanced Simulation and Modelling of Virtual Systems (ASiMoV) programme. This industry-university partnership aims to deliver the modelling, simulation techniques and software technologies needed to bring virtual certification into the aerospace propulsion sector.

"I can't recommend the Industry Fellowship scheme more highly for ensuring that great science permeates between the outstanding universities and leading industries that we have in the UK."



Right:
Artist's impression of Rolls-Royce's UltraFan®, a scalable jet engine design suitable for widebody or narrowbody aircraft which offers a 25% fuel efficiency improvement over the first-generation of Rolls-Royce Trent engine. © Rolls-Royce.

Professor Hywel Morgan MBE

Royal Society Industry Fellow (2013 – 2017)

Professor Hywel Morgan is Professor of Bioelectronics at the University of Southampton, with an interest in translating fundamental research into applications, technologies and products. After completing an Industry Fellowship in 2017, Hywel went on to co-develop a revolutionary antimicrobial susceptibility test. He patented the technology alongside a co-inventor and iFAST Diagnostics emerged as a spinout from the University of Southampton in 2022, with Hywel as Chief Technology Officer.

Trained in both engineering and biology, Hywel has produced engineering devices that have been used in a wide range of sectors. During his Industry fellowship he worked with global consumer electronics companies to develop a new technology based on the displays found in devices such as smart phones and laptop screens, using thin film transistors to manipulate tiny droplets of liquid. Hywel used the four years of his Fellowship to continue to develop and commercialise this digital microfluidics technology and establish important business connections.

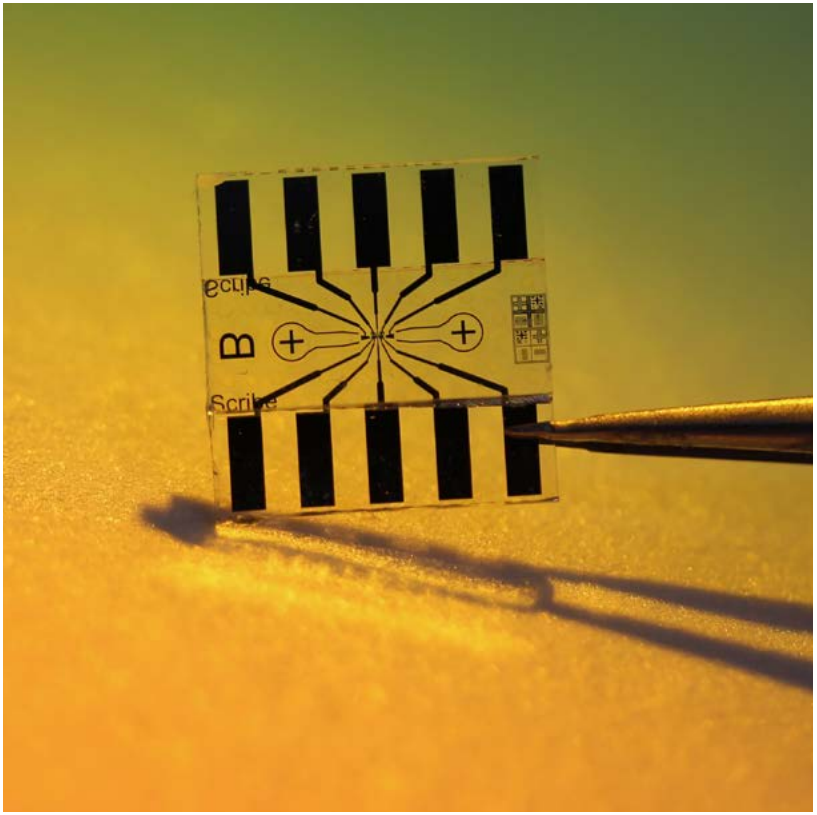
Hywel has now developed a rapid test, known as iFAST, that measures the phenotypic susceptibility of bacteria to antibiotics in a vastly shorter timespan than current methods allow. Antimicrobial resistance is one of the top public health threats, having been responsible for over 1 million global deaths in 2019.

The bacteria present in the patient's sample are exposed to different antibiotics for an hour, before being passed down a microfluidic channel where the electrical properties of many thousand single organisms are measured in less than a minute. These electrical properties indicate if the bacteria are sensitive or resistant to a drug before physicians then use the results to prescribe the optimal treatment. This reduces the time to identify appropriate treatment to a few hours, rather than several days, during which inappropriate antibiotics can occasionally be prescribed.

The technique can be applied to many different infections but the current aim is to speed up the analysis of blood-stream infections, where rapid diagnosis saves lives. iFAST Diagnostics currently has twelve employees and has completed trials in three hospitals in the south of England, with further financing planned for regulatory approval and scale-up. If successful, it has the potential to revolutionize antimicrobial susceptibility testing across the world.

“The Royal Society provided me with the time, tools, and confidence to develop my ideas further. The Industry Fellowship opened doors and allowed me to establish important connections within my sector.”

Below:
iFAST chips made in the laboratory.



Dr Nessa Carey

Royal Society Entrepreneur in Residence (2020 – 2022), The University of Oxford

Dr Carey became an Entrepreneur in Residence at the University of Oxford in 2020. After completing a PhD in Virology at the University of Edinburgh, Nessa spent a few years lecturing before moving into industry to work in drug discovery, motivated by a desire to make a real-life difference to patients.

After nearly 20 years in the pharmaceutical sector, Nessa left the industry to focus on supporting start-ups and spinouts through her own consultancy business. It was during this time that Nessa became an Entrepreneur in Residence, after being made aware of the scheme by a Royal Society staff member.

The initial aim of Nessa's residency was to create a network of experts that could support early-stage innovators in Oxford's Medical Sciences department, which then expanded to supporting any innovation that had a potential medical output. If an innovator approached the network with an idea they believed had the potential for impact, they were connected to the relevant expert, who provided advice and guidance to help shape the idea further. The network has a distinctive focus on supporting early stage innovators and is still active two years after the end of Nessa's formal residency.

Having initially started from Nessa's personal contacts in the pharmaceutical sector, the network steadily grew through the introduction of contacts from other experts. It now consists of approximately 30 individuals from a variety of sectors, who each support academics interested in commercialising their research. This could be through a variety of activities such as helping with grant applications, running interactive training courses, organising translational research days featuring talks by the experts, or acting as panel members for internal translational funding schemes and running mock interviews. The idea was to create a project that could continue even after the completion of Nessa's residency, and the result has created a long-term culture change at the university towards entrepreneurship.

Although no longer an Entrepreneur in Residence, Nessa continues to work closely with the university and supporting early-stage innovators. Looking to the future, Nessa is passionate about preparing STEM graduates for careers outside of academia as well as encouraging more women to apply for grant schemes such as the Entrepreneur in Residence award.

"The Royal Society Entrepreneur in Residence scheme is the most fun I've had in my career. It's also one of the highest impact jobs I've had, and it's been great to work on a project where you can see you're genuinely making a difference."

Dr Mike Murray

Royal Society Entrepreneur in Residence (2019 – 2022), The University of Sheffield

Dr Mike Murray has had a career in business development for a number of biotechnology companies following a PhD in molecular genetics. Interested in training and coaching, and passionate about promoting alternative STEM careers outside of academia, Mike applied for the Entrepreneur in Residence award in 2018 with the University of Sheffield.

The aim of his project was to raise awareness of the commercial dimension of science and the value of career opportunities that exist outside the realm of academia, having noticed that guidance was lacking in many higher education institutions. He worked with the School of Medicine to create a training programme on the commercialisation of research, delivering two of the seven sessions in-person before the COVID pandemic moved the course online. Mike moulded the course to suit the training needs of students, giving them the skills, confidence and inspiration to pursue careers outside of academia. University lecturers also attended, with course graduates going on to work in consultancy, begin patent traineeships, or found their own companies. Two companies that were founded following the programme were MetalloBio Ltd and Exciting Instruments Ltd.

A key part of Mike's residency was teaching early career researchers how to conduct effective market assessment interviews to determine the potential market interest for their invention. He trained approximately 50 scientists and has continued to do so after his Royal Society residency came to an end.

The programme is now embedded within the University of Sheffield, with the long-term plan to make the offering available to external businesses which have potential ideas for a commercial product.

Mike also became a mentor for students applying to Innovate UK's ICURe programme. In particular, he became a business mentor for MetalloBio, a company developing novel antimicrobial leads to combat multi-drug resistant bacteria founded by a student who had undertaken Mike's commercialisation training courses. Mike is now a board member of the business as Executive Chairman and is working to progress the company forwards in the role of Interim CEO.

Although having finished his award, the relationships formed during this time are still growing and Mike continues to work with students at the university on an ad hoc basis. His residency contributed to a culture change that was already underway within the university, where innovation entrepreneurship and commercialisation are actively encouraged and increasingly well-supported.

"There is a volume of opportunity for scientists outside of careers in academia. My Entrepreneur in Residence project helped students realise this potential and take their research in directions they didn't think was possible."

The Royal Society

The Royal Society is a self-governing Fellowship of many of the world's most distinguished scientists drawn from all areas of science, engineering, and medicine. The Society's fundamental purpose, reflected in its founding Charters of the 1660s, is to recognise, promote, and support excellence in science and to encourage the development and use of science for the benefit of humanity.

The Society's strategic priorities are:

- The Fellowship, Foreign Membership and beyond
- Influencing
- Research system and culture
- Science and society
- Corporate and governance

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Founded in 1660, the Royal Society is the independent scientific academy of the UK, dedicated to promoting excellence in science

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Cover image

A section of the Mississippi River modelled in Fathom's digital elevation model, FABDEM+ (see page 6 for more details).