

AnnualReview

2015/2016



Strategic challenges

As the UK's national academy for engineering, we bring together the most successful and talented engineers for a shared purpose: to advance and promote excellence in engineering.

We provide analysis and policy support to promote the UK's role as a great place to do business. We take a lead on engineering education and we invest in the UK's world-class research base to underpin innovation. We work to improve public awareness and understanding of engineering.

We are a national academy with a global outlook and use our international partnerships to ensure that the UK benefits from international networks, expertise and investment.

We have four strategic objectives, each of which provides a key contribution to a strong and vibrant engineering sector and to the health and wealth of society.

Make the UK the leading nation for engineering innovation

Supporting the development of successful engineering innovation and businesses in the UK in order to create wealth, employment and benefit for the nation.

Address the engineering skills crisis

Meeting the UK's needs by inspiring a generation of young people from all backgrounds and equipping them with the high quality skills they need for a rewarding career in engineering.

Position engineering at the heart of society

Improving public awareness and recognition of the crucial role of engineers everywhere.

Lead the profession

Harnessing the expertise, energy and capacity of the profession to provide strategic direction for engineering and collaborate on solutions to engineering grand challenges.

The Royal Academy of Engineering
Incorporated by Royal Charter

HRH The Prince Philip Duke of Edinburgh KG KT OM GBE
Senior Fellow

HRH The Princess Royal KG KT GCVO QSO
Royal Fellow

HRH The Duke of Kent KG GCMG GCVO
Royal Fellow

Professor Dame Ann Dowling OM DBE FREng FRS
President

Front cover image courtesy of Alvise Simondetti at Arup



Contents



Dame Ann Dowling OM DBE FREng FRS, President	2
Philip Greenish CBE, Chief Executive	4
Highlights of the year by theme	6
Make the UK the leading nation for engineering innovation	8
Address the engineering skills crisis	13
Position engineering at the heart of society	18
Lead the profession	23
Greatly enhance the Academy's delivery capability	28
New Fellows 2015	31



Dame Ann Dowling

OM DBE FREng FRS, President



Dame Ann Dowling has been the Academy's president since September 2014. She looks back on recent achievements and what the Academy will need to focus on in the coming year.

Q What have been your particular priorities for the last year?

A A lot of our work in the run-up to the general election was focused on communicating the value of investment in engineering research and innovation. This work continued as the new government was formed and conducted a comprehensive Spending Review in which all government expenditure was scrutinised, including the grants given to the national academies. We had to put together a very clear and compelling case for maintaining public investment in the Academy's work across research and innovation, policy advice, international networks, engineering education and skills and engaging the public with engineering. I'm very grateful for all the hard work put in by Fellows and staff to make this happen.

The outcome of the Spending Review for science and engineering and for the national academies was positive. The Academy's settlement will allow us

to continue our work up to 2020 and considerably expands the base of our government-funded activity by making us a delivery partner for the new Global Challenges Research Fund.

Another important task arose when government asked me to lead a review of how relationships between UK businesses and the UK's world-leading university researchers could be better supported. I was very grateful for the 215 submissions I received and to the numerous others, from both academia and business, who provided input for the review, which identified how the complexity of the landscape is a major barrier to collaboration. The resulting recommendations (see page 9) were well received by Jo Johnson MP, Minister of State for Universities and Science, have been cited in the Chancellor's Productivity Plan, the 2015 Budget and the white paper on higher education, *Success as a Knowledge Economy: Teaching Excellence, Social Mobility and Student Choice*, and at the time of writing, were



It would be almost impossible to define the Academy's success through a single moment or initiative. I think it would be fair to say that the organisation now enjoys a higher reputation and more positive impact and influence than ever before.

helping to shape the government's National Innovation Plan.

There have of course been many other success stories besides. With support from the Worshipful Company of Engineers, we have launched the RAEng Engineers Trust Young Engineer of the Year awards, which aim to recognise engineers who have made a significant contribution at the start of their career. The Enterprise Hub has introduced the Royal Academy of Engineering 1851 Royal Commission Enterprise Fellowships scheme, its first grant exclusively aimed at supporting recent UK engineering graduates. It has also established the Innovators' Network, which aims to create a community of SMEs and corporates seeking to overcome the challenges associated with innovation in engineering through knowledge sharing. We have established a new engineering project in Lowestoft to bring the excitement of engineering into the classroom in a disadvantaged area of the country with an engineering heritage (see page 14). The Academy also played a part in organising and supporting the Global Grand Challenges Summit in Beijing in September 2015 (see page 25). It has been a big year and it has set us up for some even more exciting times ahead.

Q Where do you think that the Academy could do better?

A We can always learn from our experiences and we continually look to improve what we do based on careful evaluation and learning from experience.

We know that our Fellows have an appetite to drive growth and change for the UK and across the world, and so our strategic plan maps ambitious objectives. We will be launching a major campaign to create the partnerships and sources of funding to deliver a step change in the Academy's delivery capacity to support this.

One of the objectives still to tackle is the worrying shortfall of young people joining the profession at every level. This is a challenge that the whole of engineering

needs to be better at addressing, and we are developing the Engineering Talent Project (see page 15) to bring together all the good work already being done in the profession and transform perceptions of engineering.

We continue work to ensure that we are engaging a greater number of our Fellows in our activities, and we are currently reviewing what works best for them. The Fellowship is the lifeblood of the Academy and I really want to find a way to increase their involvement even more.

Q What will your priorities be over the next year?

A The research and innovation landscape continues to evolve, and having reviewed business-university research collaborations for the government and advised on the proposed changes to the landscape, I would like to remain closely involved in ensuring that recommendations that were discussed are implemented in a way that boosts the growth and impact of the engineering sector.

This year, we also have a significant opportunity to expand our impact internationally. We are the UK's national academy for engineering but having a global outlook is crucial to our mission. The projects we are developing to deliver the Global Challenges Research Fund and Newton Fund build on our experience and expertise in supporting innovation and growing engineering capacity both in the UK and in the developing world.

In September 2016, we host a major conference focusing on the impact of engineering on international development, which will mark the launch of several new initiatives and the beginning of a longer term initiative to encourage closer working between the engineering and international development professions on major global challenges.

Finally, while it fell after the end of the financial year, our greatest priority for

the year ahead was determined by the result of the EU Referendum on 23 June. As the UK's national academy of engineering, we will be leading efforts to provide the government with clear, evidence-based information to inform the forthcoming negotiations and ensure that the needs of all sectors that have a dependence on engineering are represented and understood. This work unites all 38 organisations representing the engineering profession to secure the best possible outcome for the UK.

Q The Academy turned 40 in June 2016. What do you think is the Academy's most significant achievement since it was founded?

A It would be almost impossible to define the Academy's success through a single moment or initiative. I think it would be fair to say that the organisation now enjoys a higher reputation and more positive impact and influence than ever before.

A snapshot of our work in the last year gives a flavour of what we have achieved: we have a wonderful Fellowship of 1,500 of the most eminent engineers who give 12,000 hours of their time voluntarily for the national good; we have directly supported teachers in 500 UK schools; we have collaborated with 30 countries on over 100 international projects to foster engineering and innovation; we engaged 4,000 members of the public through more than 60 events, achieved 3,000 pieces of media coverage and had 1.2 million visits to our website. We are a small organisation and we should be very proud of that achievement.

Philip Greenish CBE

Chief Executive



Philip Greenish talks about the challenges that the engineering community has faced and the Academy's role in placing engineering at the heart of society.

Q What have been the challenges for the Academy's management team and staff this year?

A A number of important changes have been introduced to support the Academy's performance as we develop and grow. The Trustee Board agreed to the creation of a new post of Director of Strategy and Deputy CEO to support change management and help drive the strategic plan. Dr Hayaatun Sillem, formerly Director of Programmes and Fellowship, was appointed to this role in 2016.

As the number of programmes and initiatives we administer has increased, we have needed to make sure that we have the staff to work with Fellows and partners and keep pace with that growth. So we have welcomed a number of talented new people to the organisation to grow our capacity.

A larger number of staff requires new and more consistent ways of working.

An important change to our approach was a review of our remuneration framework which allowed us to create a transparent, consistent approach to how we set staff salaries. We have overhauled our internal communications procedures to ensure that they support effective and efficient working and have reviewed a number of our staff policies so that they are in line with best practice.

Preparations for the redevelopment of the Academy's lower ground floor to provide a state-of-the-art home for the Enterprise Hub, together with new kitchens and services, took most of the year and work is now well underway. There is real complexity in creating fully useable space from a large, undeveloped and leaky basement in a Grade 1 listed building. However, I am confident that we will deliver a vibrant, appealing place for the Hub and where Fellows and budding entrepreneurs will meet, network and share ideas. The work, which is set to complete at the end of 2016, has been

kick-started by generous donations from Dr John C Taylor OBE FREng and the late Geoffrey Argent FREng.

Q How would you describe the Academy's networks?

A Partnership working is absolutely critical to the Academy's mission and so we put a lot of emphasis on ensuring that we have thriving working relationships with our very wide range of partners and supporters across the profession, in business and industry, academia, the third sector and government.

Our ambitious strategic plan means that we are always looking to broaden our reach and create new partnerships both in the UK and overseas.

We want to ensure that we work more closely with our wider family of awardees and grant recipients and we are looking to develop a more formal alumni network to support this.

ensure that our own practice is as open and transparent as possible and to avoid unconscious bias in our selection processes.

Q The Academy turned 40 in June 2016. What would you like to see it achieve in the next 40 years?

A The Academy has a leadership role in the profession and it will be important to develop this aspect of our work so that the profession is fit to tackle the challenges of the future. We can and should be creating a louder voice for engineering and driving changes in policy, perceptions of engineering and engineering practice that allow society and the economy to thrive. My vision is of a fuller pipeline of inspired and talented young people joining the profession, and a nation with engineering at its heart and recognising it. As engineering grows, society will too: that is hugely exciting.

Q What progress has the Academy made in its work on diversity in engineering?

A The last year saw the conclusion of the first phase of our Diversity Programme, which the Academy established in 2011 with support from the Department for Business, Innovation and Skills to drive action on diversity across the profession. Independent evaluation has shown us that the programme (see pages 16-17) has successfully raised awareness, shared best practice and driven change across the profession. The programme has directly engaged 50 employers and employer-led organisations through the Diversity Leadership Group and established an Engineering Diversity Concordat, which 32 organisations have signed in support of increasing diversity and inclusion across professional engineering institutions.

We have rolled out diversity awareness and training across the Academy's committees and among the staff to



The Academy has a leadership role in the profession and it will be important to develop this aspect of our work so that the profession is fit to tackle the challenges of the future.

Highlights of the year by theme

Energy system study

A critical time for UK energy policy: what must be done now to deliver the UK's future energy system was the third in a series of reports for the Prime Minister's Council for Science and Technology, and assesses the actions needed now to secure a sustainable future energy supply for the UK.

Overall, the report found that delivery of the UK's future energy system is under serious threat and substantial investment is needed.

The report gained widespread media coverage, with more than **70** mentions in print and on TV and radio.

Other energy highlights

The MacRobert Award for innovation in UK engineering was awarded to a team from Artemis Intelligent Power for its Digital Displacement power system using digitally controlled hydraulics, which has the potential to transform the viability of offshore wind power and low-carbon transportation.

The Academy appeared before the Economy, Energy and Tourism Committee of the Scottish Parliament to discuss energy security.

Enterprise Hub

Eight new Enterprise Fellows were awarded grants of up to **£60,000** each.

The Enterprise Hub launched two new initiatives. 1851 Royal Commission Enterprise Fellowships, supported by the Royal Commission for the Exhibition of 1851, offer three engineering graduates a **£50,000** grant as well as Hub membership; the Innovators' Network brings together innovation champions within larger corporates and SMEs to share best practice and drive improvements in performance.

International schemes

176 innovators from **12** emerging economies were trained by the Academy under the Newton Fund Leaders in Innovation Fellowship programme.

Dr Askwar Hilonga, a chemical engineer from rural Tanzania, won the first Africa Prize for his innovation using nanotechnology to create bespoke water filters for particular contaminants. Dr Hilonga was then invited to participate in the inaugural Pitch@Palace Africa competition and was declared overall winner.

University programmes

More than **100** Research Chairs and Research Fellowships were in post, and **6** new Industrial Secondment Scheme awards were made.

41 universities hosted Academy Visiting Professors who are practising engineers working to improve the relevance of engineering teaching for undergraduates.

Academy President, Dame Ann Dowling OM DBE FREng FRS, published her *Review of Business-University Research Collaborations* for the government, which offered advice and recommendations on how relationships between businesses and universities could be better supported.

The Aerospace MSc Bursary Scheme awarded its **500th** bursary for new entrants to the UK aerospace industry and for upskilling people already in the sector.

Supporting smaller businesses

Pathways to Growth grants were awarded to **18** SMEs to help them upskill their engineers and technicians.

The Launchpad Competition enabled budding engineering entrepreneurs aged 16 to 25 to start a new business. All four finalists in the competition were invited to join the Enterprise Hub.

Business and
manufacturing

Energy and
natural resources

Innovation and
entrepreneurship

Built environment study

Published in July 2015, this report explored the relationship between the design of the built environment and human behaviour as well as the implications for design practice, research needs and policymaking.

The report highlighted how design and human behaviour are interlinked, and concluded that stakeholders need to collaborate to capitalise on what is already known about both.

Its publication followed three workshops that looked at ways in which the design of the built environment can have a significant impact on resource use, health and wellbeing, and performance and productivity.

Transport congestion

The Academy's first 'challenge paper' addressed the growing problem of congestion on the UK's road and rail networks.

Led by Fellows with expertise in transport, the discussion document focused on the costs and congestion reduction potential of a number of different measures and identified **18** 'frontrunners' that offer the best value for money.

Infrastructure
and transport

Technology and
society

People and talent

Queen Elizabeth Prize for Engineering

In October, Dr Robert Langer FREng received the Queen Elizabeth Prize for Engineering trophy from HM The Queen during a ceremony at Buckingham Palace.

The ceremony generated global media coverage across outlets including the wider BBC networks, *The Times*, the *Washington Post*, *China Daily* and the *Times of India*, reaching a worldwide audience of more than **1.25** billion people.

The first QEPrize report *Create the Future* was published, revealing the changing nature of engineering perceptions and providing insights into the differences in these perceptions between countries.

Partnerships

Seven major engineering employers convened to provide strategic support for the Academy-led Engineering Talent Project, a social marketing programme designed to change perceptions of engineering and address the engineering skills crisis.

Alongside other national academies, the Academy hosted roundtable meetings at the Conservative, Labour and Scottish National Party conferences.

Eight Academy Fellows and awardees spoke at the second Global Grand Challenges Summit, part of a three-year collaboration between the UK, USA and Chinese national academies on the contribution engineering can make to meeting common global challenges.

Influencing education policy

The *Does teaching advance your academic career?* report found that UK engineering academics believe that the quality of their teaching has little value on their careers, and identified a series of issues deeply ingrained in university culture, including the overwhelming emphasis on research reputation and income when it comes to promotion, academic mobility and allocation of resources.

The Academy-hosted Education for Engineering alliance provided expert advice on apprenticeships, and new content for engineering qualifications and enabling subjects at GCSE and A level.

Diversity

The Diversity Leadership Group launched a toolkit developed with and for employers called *Increasing diversity and inclusion in engineering* at an event attended by more than **100** stakeholders.

The Academy hosted around **160** students at a combination of a summer school and engineering fast-track workshops as part of the Engineering Engagement Programme, which aims to attract undergraduates from diverse backgrounds into engineering employment.

Make the UK the leading nation for engineering innovation

The Academy's first strategic challenge is to support the development of successful engineering innovation and businesses in the UK in order to create employment, wealth and benefit for the nation.

Ahead of the 2015 Spending Review, it became apparent that there was a need for an evidence-based case for continued investment in UK research and innovation, demonstrating the value of government support to secure the UK's future growth. The resulting report, *Investing in Innovation*, published by the Academy in September 2015, received significant coverage in the media, as well as forming the basis for the Academy's submission to the House of Commons Science & Technology Committee's science budget inquiry.

The outcomes of the 2015 Spending Review were broadly positive for research and innovation. However, significant changes to the UK's research and innovation landscape were proposed. The Academy provided major input to the government's consultations on its proposals, submitting responses and

convening relevant stakeholders; work that is ongoing. An overarching message from the Academy is the need for a clearly articulated and stable strategic policy framework from government to accompany the changes.

Complementing this work, the Academy, along with its sister national academies, organised a series of four public *Policy Lab* events to bring together relevant stakeholders to discuss the future of the UK's research and innovation landscape following the 2015 Spending Review.

During the course of the year, the Academy substantially increased its contribution to policy discussions on research, innovation and enterprise, ensuring that the engineering voice was heard in a crucial year for the community.

Research

The Research Fellowship scheme provides outstanding early-career researchers with five years' funding and mentorship to help them establish themselves as future research leaders. The scheme is highly competitive and eight new appointments were made during the year, with one supported by the Lloyd's Register Foundation. The Academy's Research Fellows are currently distributed across 20 different universities. The Research Chairs and Senior Research Fellowships scheme, co-funded by industry, helps to establish and enhance world-leading 'use-inspired' collaborative research programmes at UK universities. The scheme currently supports more than 40 partnerships covering a wide range of engineering disciplines and technology areas, from low carbon technologies to interfacial nanoscience for engineering systems.

The Leverhulme Trust Senior Research Fellowships scheme, funded by The Leverhulme Trust, enables mid-career



Dr Patricia Perez Esteban (centre) is presented with her gold medal award at the SET for Britain poster competition at Parliament by (L-R) Dr Stephen Benn, 3rd Viscount Stansgate, Royal Society of Biology Director of Parliamentary Affairs and SET for Britain Master of Ceremonies; Academy President Dame Ann Dowling OM DBE FREng FRS; Colin Dixon, Head of Marketing at Essar Oil UK; and Stephen Metcalfe MP, Chairman of the Parliamentary and Scientific Committee

The Dowling Review

In July 2015, the President launched her *Review of Business-University Research Collaborations* at the House of Commons, where it was welcomed by Jo Johnson MP, Minister of State for Universities and Science.

In December 2014, the President had been invited by the then Minister for Universities, Science and Cities, Rt Hon Greg Clark MP, to lead a review to develop advice and recommendations on how relationships between UK businesses and the UK's world-leading university researchers could be better supported.

The President assembled a review group comprising experts and practitioners in collaboration from a wide range of disciplines, representing both industry and academia. The level of participation from the research and business community exceeded expectations. Over 200 written submissions from across a broad spectrum of stakeholders were received, and more than 200 individuals participated in meetings held across the country. This engagement generated recommendations that clustered into six broad topics: complexity, people, brokerage, growing

critical mass, terms of engagement and government strategy.

The overarching recommendation was that, wherever possible, government should seek to reduce complexity in the public support system for collaboration. Where it is not possible, every effort should be made to 'hide the wiring' from those seeking support.

The reception was positive and the review was cited in the Chancellor's Productivity Plan, the 2015 Budget and the white paper on higher education, *Success as a Knowledge Economy: Teaching Excellence, Social Mobility and Student Choice*.

An official response from government is expected, but in the meantime it appears that many recommendations have been embraced by the wider research and innovation community.

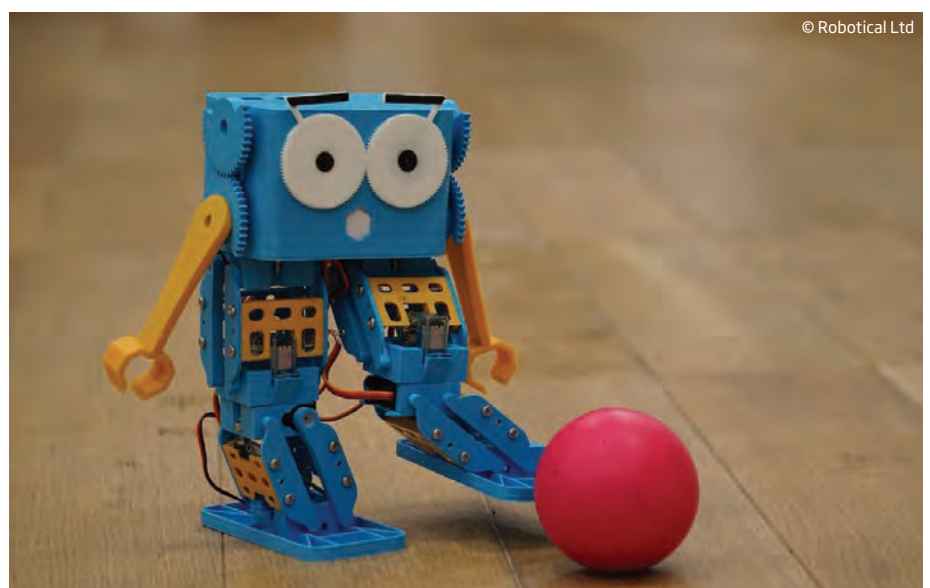
academics with a proven track record in research to be relieved of their day-to-day activities in order to concentrate full time on research. Each Fellowship pays for a replacement academic to cover their teaching and administrative workloads for up to one year. In February 2016, seven Leverhulme Trust Senior Research Fellowships were awarded. The Academy's Industrial Secondment Scheme supports early- to mid-career academics wishing to undertake a collaborative research project in an industrial environment, which can help to improve the quality and industrial relevance of their teaching and promote research collaboration. In July 2015, 10 new secondments were awarded.

The Academy's annual Research Forum brings together Fellows, beneficiaries, engineering researchers, industry partners, research funders and government representatives to celebrate excellence in engineering research. The September 2015 event, hosted by Professor Ric Parker CBE FREng, provided an opportunity for individuals undertaking cutting-edge engineering research, their industry sponsors and a host of interested parties to meet and hear about the wide range of work that is currently underway. The day concluded with a lively panel discussion on the impact of world-leading research and innovation on growth and productivity. Panel members included: Professor Sir Peter Gregson DL FREng, Vice Chancellor of Cranfield University; Professor Philip Nelson FREng, Chief Executive of the Engineering and Physical Sciences Research Council; Professor Mary Ryan FREng, Shell/Royal Academy of Engineering Research Chair at Imperial College London; and Paul Mason, Head of Development at Innovate UK.

SET for Britain is a national poster competition open to early-career researchers in science, technology, engineering and maths (STEM). Run by the Parliamentary and Scientific Committee in partnership with the Academy and other science and engineering organisations, the event provides a valuable opportunity for Parliamentarians to engage directly with scientists and engineers. At the March 2016 event, 60 engineering applicants presented their posters and the President awarded the gold, silver and bronze medal winners their prizes. The gold medal and £3,000 prize were awarded to Dr Patricia Perez Esteban, a chemical engineer from the University of Bath, for her poster on developing an animal-free cosmetic testing model to better predict how compounds enter the bloodstream.

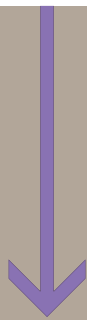
Enterprise Hub

The Enterprise Hub forms a key part of the Academy's commitment to stimulating excellence and promoting creativity and innovation in engineering. It identifies the founders and leaders of tomorrow's technology companies and provides bespoke support and mentoring from the Academy's Fellowship. To date, the 38 early-stage Hub members have raised around £23 million of external funding, with more than 90 employees associated with their companies. The Hub portfolio is diverse, supporting a wide spectrum of engineering and technology start-ups on their entrepreneurial journey, from modifiable robots teaching children to code to 'breathing bricks' to reduce waste in construction.



© Robotical Ltd

Enterprise Fellow Dr Alex Enoch's 3D-printed robot can be programmed to walk, dance or even play football



At a glance

Enterprise Fellows and their innovations

Alexander Enoch, University of Edinburgh

Educational walking robots that can be wirelessly reprogrammed, modified with new 3D-printed parts and controlled via smartphone.

Damien Coyle, Ulster University

NeuroCONCISE wearable technology measures and translates brainwaves into control signals that allow physically impaired people to communicate and interact with computers.

Yiang Li, University of Southampton

Using software to automatically generate transcript and captions from audio or video to make lectures accessible at a lower cost and faster.

Andrew Marsden, University of Cambridge

Nano-materials for gas storage and separation that could dramatically lower the cost of storing, separating and transporting gases.

Samuel Chapman, Heriot-Watt University

Unfired bricks that reduce waste and CO₂ in the construction sector by using traditional earth-construction methods, 90% recycled content and no cement.

Oliver Stevens, University of Bristol, University of Exeter and Gloucestershire Hospitals NHS Foundation Trust

Revolutionary technology for cancer screening, enabling on-the-spot cancer diagnosis with minimal discomfort for patients.

Nick Everdell, University College London

A pioneering mobile imaging system that enables imaging of the brain while the subject engages in normal activities, rather than being confined to a scanner.

Silo Meoto, University College London

A dental bone graft substitute that repairs bone defects prior to dental implant placement and can potentially achieve 95% integration with surrounding bone in just three months.



Finalists in the Enterprise Hub's 2015 Launchpad Competition

Over the past year, the Enterprise Hub has emerged from its own start-up stage and established its reputation so that its programmes now attract a record number of engineering applicants from around the country. In response to the evolving needs of engineering and technology entrepreneurs, the Hub has launched two new initiatives:

- **1851 Royal Commission Enterprise Fellowships:** with generous support from the Royal Commission for the Exhibition of 1851, this new programme offers engineering graduates a £50,000 grant as well as Enterprise Hub membership.
- **Innovators' Network:** chaired by Elspeth Finch, an entrepreneur and former Director of Innovation (UK & Europe) at Atkins, the network brings together innovation champions within corporates and SMEs to share best practice and drive improvements in innovation performance across sectors and technology areas.

The Academy's Launchpad Competition enables a budding engineering entrepreneur aged 16 to 25 to start a new business based on their engineering innovation. This year, all four Launchpad Competition finalists were invited to join the Hub. The 2015 winner, James Roberts, developed his low-cost inflatable incubator with the aim of preventing premature baby deaths in the developing world. Finalist Sorin Popa went on to win the 2016 Royal Academy of Engineering ERA Foundation Entrepreneurs Award for his stent placement technology that improves outcomes for kidney dialysis patients. Another 18 SMEs have been awarded training grants from the Hub's Pathways to Growth scheme to help them upskill their engineers and technicians as new technologies and business needs emerge.

The Blavatnik Family Foundation Alumni Awards celebrate progress made by Enterprise Fellows during and after their Fellowships. The most recent winners were Dr Daniel Plant, Dr Toby Basey-Fisher and Dr Stephen Smith. All were recognised for their

efforts to turn their innovative technologies into viable businesses and their continued commitment to acting as role models for the next generation of entrepreneurial engineers.

Two Hub members also secured agreements for investments at the 2015 showcase, which featured keynote talks by speakers from Raspberry Pi and Google DeepMind. In January 2016, the Chair of the Enterprise Committee, Ian Shott CBE FREng, hosted a 'reverse pitching' event giving Enterprise Hub members and Pathways to Growth SMEs a chance to turn the tables and put the investors in the hot seat. The event was aimed at demystifying the funding landscape for earlier-stage entrepreneurs, and introduced Hub members to a powerful network of potential backers.

There has been significant media interest in the engineering technologies pioneered by Hub members in local and national newspapers, industry press, online and national television. The announcement of the cohort of Enterprise Fellows in March 2016 was featured in *The Daily Telegraph* and on BBC News. Hub members have also achieved widespread success elsewhere. George Frodsham's drug-free malaria treatment start-up MediSieve was a runner-up at the Pitch@Palace event; Dr Susannah Clarke, co-founder of a company that develops precision instrumentation for orthopaedic surgery, was awarded a Royal Academy of Engineering Silver Medal; and Bethan Wolfenden's portable DNA testing kit, Bento Lab, reached its Kickstarter funding goal in less than 36 hours.

The Hub continues to build a strong network of partners, including investment groups, specialist advisory firms and corporate organisations, and its activities continue to grow in scale and impact. By early 2017, the lower ground floor of Prince Philip House will have been developed into a physical home for the Hub, providing a welcoming space where Hub members, Hub partners and Academy



A member of the Artemis Intelligent Power team tests the performance of a 1.5 MW Digital Displacement motor

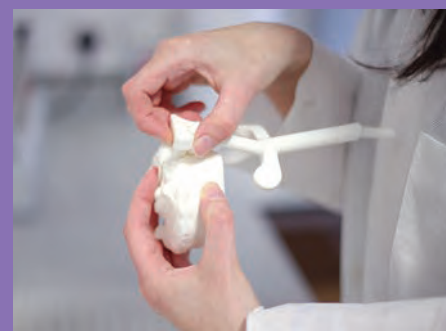
Awards

The Academy's awards celebrate the significant contribution of engineering to the nation's wealth, health and wellbeing, and recognise engineers at all stages of their careers.

MacRobert Award

The MacRobert Award is a £50,000 prize awarded annually to a team of engineers for an exceptional innovation in UK engineering that has been commercially successful and delivered benefits to society.

In June 2015, the winner was a team from Edinburgh-based Artemis Intelligent Power for its Digital Displacement power system using digitally controlled hydraulics, which has the potential to transform the viability of offshore wind power and low-carbon transportation. As well as dramatically improving power capacity, the smart, modular system has been designed to overcome the significant reliability issues associated with existing turbines.



A 3D-printed surgical guide for joint replacement is held by Silver Medallist Dr Susannah Clarke, co-founder of Embody Orthopaedics

Silver Medals

The Academy's Silver Medals are awarded to outstanding individuals in recognition of their personal contributions to UK engineering. The award recognises individuals' success in creating and bringing a particular innovation to market. In 2015, the Silver Medallists were:

- **Dr Susannah Clarke**, co-founder of Embody Orthopaedics, a spin-out from Imperial College London. She is pioneering new medical techniques using 3D-printing technology to revolutionise joint replacements.
- **Dr Don Syme**, principal researcher at Microsoft Research, Cambridge, where he works to improve the tools available to programmers worldwide, helping them create the building blocks of the virtual world more effectively. He created the F# computer programming language.
- **Dr Andy Ward**, founder and Chief Technology Officer at UbiSense, a location intelligence provider that can track individual items in a factory and automate the processes between them.

Fellows can interact, and creating a focal point for excellence in engineering innovation and entrepreneurship.

International activities

The Academy is a delivery partner for the government's Newton Fund, which supports science and innovation partnerships with emerging economies. One of the Academy's flagship Newton Fund activities is the Leaders in Innovation Fellowships programme, which helps entrepreneurial researchers across the globe commercialise innovations that address development challenges. In the past two years, the Academy has supported 320 technology innovators from 12 countries in Latin America, Africa and Asia. The researchers from these partner countries benefit from an intensive period of training and coaching in the UK, masterclasses from Academy Fellows and opportunities to network with their UK peers.

The training ends with a competitive pitching session in front of a judging panel headed up by an Academy Fellow.

The programme has already had a significant impact, both in terms of progressing individual innovations and influencing changes in the partner countries' culture of research entrepreneurship. Work is now underway to expand the list of partner countries and provide better networking opportunities for alumni with each other and with potential funders through regional hubs in Southeast Asia and Latin America.

Under the Newton Fund, the Academy also initiated the Industry Academia Partnership Programme to promote bilateral, inter-sector links that address engineering higher education and research and innovation challenges in partner countries. The Academy hosted scoping workshops in India and South Africa that brought together senior

figures from across government, industry and academia to discuss core issues in the engineering sector. A grant-making programme was subsequently designed and 41 awards made, totalling £1.9 million for collaborations between the UK and Colombia, India, Kazakhstan and Thailand.

The Newton Research Collaboration Programme enables engineering researchers from the UK to work with peers from Newton Fund partner countries for a period of three months to one year. During the year, 42 exchanges were funded across six countries.

The Distinguished Visiting Fellowship scheme provides funding for UK universities to host a world-leading academic from overseas for up to a month and establish partnerships. In the last year, the scheme awarded 23 Distinguished Visiting Fellowships to academics from 10 countries to enable them to visit 15 UK universities.



Africa Prize winner Dr Askwar Hilonga with head judge Malcolm Brinded CBE FREng

Africa Prize for Engineering Innovation

The Africa Prize for Engineering Innovation was launched in March 2014 with the aim of stimulating and rewarding innovation and entrepreneurship in sub-Saharan Africa. The annual prize offers six months of training and mentoring to 12 talented entrepreneurs from across the region, before selecting a winner and runners-up to receive the prizes worth a total of £55,000.

In May 2015, Dr Askwar Hilonga, a chemical engineer from rural Tanzania, was announced as the winner of the inaugural Africa Prize. Dr Hilonga's nanofilters innovation uses nanotechnology to create bespoke water filters for particular contaminants, from heavy materials or minerals such as copper and fluoride, to biological contaminants such as bacteria and viruses, and pollutants such as pesticides.

As a result of winning the Africa Prize, Dr Hilonga was invited to participate in the first Pitch@Palace Africa competition hosted by HRH The Duke of York, Nigerian entrepreneur Aliko Dangote and former

President of Nigeria Olusegun Obasanjo. With a passionate and articulate pitch, Dr Hilonga was selected by the audience as the overall winner.

Since its launch, the Africa Prize has received entries from entrepreneurs in 16 countries across the continent and has been profiled prolifically in international print and broadcast media.

The Africa Prize is generously supported by the Shell Centenary Scholarship Fund, Consolidated Contractors Company, the Foreign & Commonwealth Office, ConocoPhillips and the Mo Ibrahim Foundation.



FEATURED FELLOW

Professor Mary Ryan FREng, Professor of Materials Science and Nanotechnology at Imperial College London, was appointed Shell/RAEng Research Chair in Interfacial Nanoscience of Engineering Material at the university.

Address the engineering skills crisis

UK employers continue to cite a shortfall of engineering skills as a key cause of concern for their future success. The UK produces only 15,000 UK domiciled engineering graduates each year. This is compared to a million graduates a year in China and 500,000 a year in India. Technician shortfalls are also affecting employers, particularly at advanced and higher skill levels.

The factors affecting supply are numerous and complex. In secondary schools, teacher shortages in critical subjects such as physics, mathematics, computing, and design and technology prevent young people from receiving the best education to lead to a career in engineering. Narrow accountability measures for schools focus attention on attainment in a limited set of academic subjects rather than the development of a broad range of creative and problem-solving skills. Careers education and guidance and employer engagement are patchy across the UK.

The further education sector, which develops the technician skills that underpin engineering, suffers from a chronic shortfall in funding and many engineering departments in higher education struggle to break even because of the high costs of provision.

One particular issue that the Academy is now

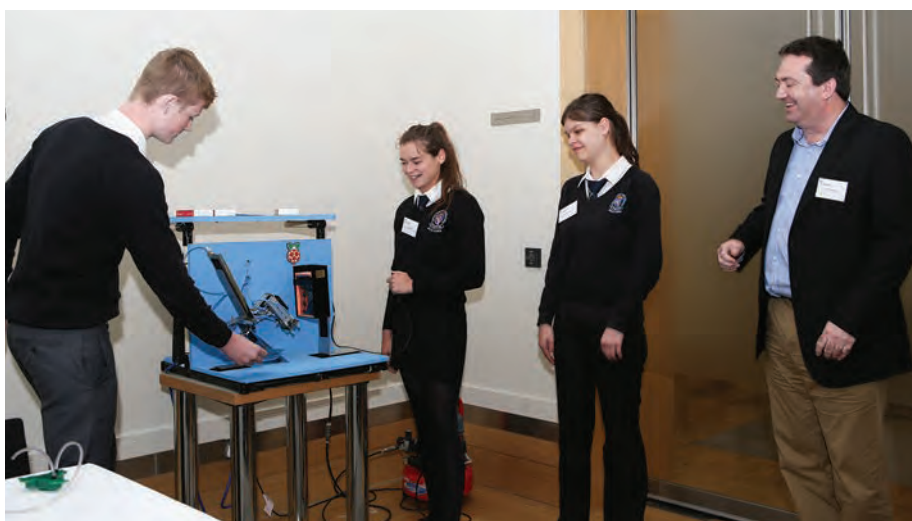
addressing on a national scale is public perceptions and attitudes towards engineering as a career. Supported by seven major UK engineering businesses, the Academy is developing a national campaign to communicate the excitement of engineering in the 21st century and the wide variety of disciplines and career opportunities available.

As the campaign develops, more industry supporters are expected to come on board. Alongside the new messages that will be developed for the campaign, the Academy is leading a policy drive to ensure that structural barriers are addressed, such as specialist teacher shortages and provision of consistent and high-quality careers guidance. There will also be an internal focus on engineering to ensure that it is genuinely attractive to future generations who have different values and expectations from previous generations of engineers.

Activities for schools

The Academy's *Connecting STEM Teachers* programme, which works to enhance the teaching and learning of STEM (science, technology, engineering and mathematics) in schools across the UK, has recruited a further 10 STEM teacher coordinators. The programme has 38 teacher coordinators who are busy supporting their regional networks, which now consist of 635 teachers from 518 schools, with training, teaching and learning resources and funding for collaborative projects between schools. It is estimated that over 96,000 school students have benefited from the programme since it was launched in September 2011.

The Academy's regional STEM support programmes, which provide opportunities



Pupils from Cynffig Comprehensive School demonstrate their system for packaging the Raspberry Pi computer at a STEM conference for the *Connecting STEM Teachers* programme held in July 2015. They are watched by Kevin Edwards, General Manager of the South Wales facility where the computers are made



At a glance

STEM education resources

10 resource boxes about various subjects:

- Winter Olympics
- Engineering ideas
- Paralympic sport
- Disaster response
- Deployable structures
- Existence at the extreme
- Hovercraft
- Drones
- Controlling motion
- Computing in Design and Technology

3,000 free resource boxes given to schools.

More than **22,000** learning and teaching resources downloaded.

Over **500** continuing professional development sessions held for teachers.



Students design and race wheelchairs developed for Paralympic athletes as part of the Lowestoft Engineering Project

for STEM engagement to students in disadvantaged areas of the UK, have also been expanded. The Lowestoft Engineering Project was launched in November 2015 and joins the existing programmes in Barrow-in-Furness (2008) and Stoke-on-Trent (2013). These three programmes, which provide funding directly to schools to enhance and enrich their STEM curricula, are cumulatively working with 32 primary schools, 15 secondary schools and six further education colleges. Over 80,000 STEM learning opportunities for local students have been provided, with activities including after-school clubs, STEM challenge days, computing/robotics challenges and visits to local employers. Continuing professional development for teachers has been provided at all levels of education and engagement. Currently, 20 local engineering employers are engaged with these regional programmes.

In the last year, the Academy has expanded the number of its STEM Club activity resources while also taking the opportunity to redesign and relaunch existing ones. The Academy has developed a new resource, *Making Waves*, to support the 2016 BAE Systems Schools Roadshow in addition to developing and launching the latest STEM teaching and learning resource, *Drones: Friend or Foe?* This gives students the opportunity to explore

how drones work and how they can be used for civilian, humanitarian and commercial purposes. Since its launch in September 2015, over 450 resource boxes and associated training materials have been disseminated to schools and the resource has been downloaded nearly 2,000 times online.

To date, the Academy has distributed nearly 3,000 resource boxes to schools and the full suite of resources has been downloaded online over 22,000 times.

In March 2016, the Academy again supported the national Big Bang Fair with a stand based on the Academy's report *Thinking like an engineer: implications for the education system*, and the six engineering habits of mind identified within it. The Academy stand challenged visitors with a series of practical activities linked to the characteristics identified in the report, and had close to 8,000 visitors over the four days.

Further and higher education

The Aerospace MSc Bursary Scheme, which was developed by the Academy, the Royal Aeronautical Society, government and leading aerospace companies, has now met



FEATURED FELLOW

Professor Peter Goodhew FREng, Emeritus Professor at the University of Liverpool, is a member of the Education and Skills Committee and is leading the Academy's support in the development of a new liberal engineering curriculum at the New Model in Technology and Engineering (University of Hereford).

Engineering Talent Project

Through the Engineering Talent Project, which is backed by seven major UK engineering businesses, the Academy is addressing public attitudes towards engineering as a career. The project aims to communicate the excitement of engineering in the 21st century and the wide range of career opportunities it offers.

The Engineering Talent Project is a multi-intervention social marketing programme designed to change perceptions of engineering and address the engineering skills crisis. It is backed by partners from major engineering organisations and has been developed in response to an appeal from industry for the Academy to take the lead in 'marketing the dream of modern engineering'. The last year has seen some significant developments in establishing strategic leadership from the engineering sector, and in achieving starter funding to get the project underway.

The project concentrates on areas where the Academy has experience and demonstrable credentials: engagement to address the barriers to creating a pipeline of future engineering talent; engineering engagement in schools; improving culture and practice across the sector to

ensure that the employment experience in engineering meets the expectations of millennials; and communications to promote engineering and its wide range of specialisms and opportunities. Importantly, employers are central to the project, and will strengthen and authenticate its messages. The findings from a rigorous programme of qualitative research show that engineering, when presented through the right messages and channels, has real potential to appeal to the next generation of untapped talent.



Awardee of the 500th Aerospace MSc bursary, Loweri Nicholls with then president of the Royal Aeronautical Society, Martin Broadhurst OBE

its target of awarding 500 bursaries for new entrants to the UK aerospace industry and for upskilling people already in the sector. The 500th bursary holder is Loweri Nicholls. Her first degree was in mathematics, which led her into a career as a credit risk analyst, but her ambition has been to go into aerospace materials engineering. The MSc course on materials science and engineering that she is studying at the University of Leeds will help her achieve this goal. The course caters specifically for students wanting to convert to materials engineering from other backgrounds.

As part of the Academy's work to enrich and maintain standards in qualifications and curricula in the further education sector, Academy representatives sit on a number of advisory committees for awarding organisations. These include the qualifications awarding body OCR's focus group for its Level 2 Technicals in Engineering qualification and Pearson External Stakeholder Advisory Groups

for its Nationals (Level 3) engineering courses as well as for Higher Nationals (Levels 4 and 5) in construction.

A new scheme for further education colleges has been launched. Visiting Teaching Engineers embeds engineers and technicians into courses so that both industry and academia can create rich and contextualised curriculum content for full-time students.

Visiting Professors

The Academy's Visiting Professors (VP) scheme is a highly valued industry-into-academia initiative to enhance both student learning and the employability of engineering undergraduates at UK universities. The

Academy's VPs play a key role in embedding an industry-focused teaching approach into the academic environment.

In September 2015, 23 new VPs were appointed and many have gone on to develop both existing and new undergraduate courses. Keith Clarke CBE HonFREng, an Academy VP, played a key role in organising Aston University's Carbon Week in November 2015. Over 2,000 undergraduate students from across the university and 200 industry guests participated in this week-long programme of activities. As well as focusing on student employability, the week was designed to improve understanding of the challenges posed by climate change and the requirements of a low-carbon economy.



Keith Clarke CBE HonFREng, Visiting Professor in sustainability, gives a presentation to students on the first day of Aston University's Carbon Week



© Sharron Wallace

Students take part in the Engineering Leadership Advanced Awards selection event

Bursaries and professional development

The Academy's Engineering Leadership Advanced Awards programme identifies and supports outstanding engineering undergraduates with the potential to become future leaders in industry and act as inspiring role models for the next generation of engineers. Over the past year, 35 award holders each received £5,000 to undertake an accelerated personal development programme, along with an annual training weekend and mentorship.

In September 2015, four Petrofac/Royal Academy of Engineering Fellowships were awarded, with recipients each given a £9,000 bursary towards an eligible full-time master's-level course at a UK university. Additional learning and development opportunities are provided by Petrofac, including a company-sourced major project, a mentor and a work placement.

Eight new Panasonic Trust Fellowships were awarded to graduate engineers during the year. This scheme supports and facilitates the professional development and technical upskilling of UK-based engineers by providing funding for the pursuit of full-time master's degree courses in the following fields: environmental technology, energy, sustainable development, natural resources, materials, and the built environment.

The Academy has continuously championed the importance of developing industrial leaders who will drive UK growth in the future. With a grant from the Gatsby Charitable

Foundation, and the personal support of Lord Sainsbury, the Academy has enabled more than 300 exceptional engineering graduates to attend the world's most prestigious business schools over the past 30 years. Nine new awards were made during the year. Following the completion of their MBA, the awardees will be supported by an extensive network of Sainsbury Management Fellowship (SMF) alumni, now managed by the SMF charity. The Academy hosted a reception in January 2016 to celebrate the relationship between the Academy, SMF awardees and the Gatsby Charitable Foundation, which was addressed by Lord Sainsbury of Turville HonFREng FRS, the President, Dame Ann Dowling, and David Falzani, President of the SMF charity. SMF alumni also play a key role in supporting a wide range of Academy

activities including the Engineering Leadership Advanced Awards.

Diversity and inclusion

The first phase of the Academy's diversity programme ended in March 2016. The programme included a number of initiatives, both Academy-led and with various stakeholders. Findings from an evaluation study by EY suggest that it has strongly supported employers, employer-led organisations and professional engineering institutions in increasing and embedding diversity in their organisations.

For over a year, the Academy has collaborated with a number of engineering employers



As part of the Engineering Engagement Programme, engineering students attend a fast-track workshop where they can meet potential employers and learn about companies' recruitment practices

Support and promotion of engineering education

The Academy provides both a physical and an intellectual forum for the engineering profession to discuss key issues.

A high priority for the profession is the creation of an education system that supports the formation of engineers at

all levels. The Academy-hosted alliance, Education for Engineering (E4E), brings together the 35 professional engineering institutions, the Engineering Council and EngineeringUK to discuss important issues and shape a common view on education and skills. Topics have included:

- Apprenticeships: E4E has responded to consultations and select committee inquiries on various aspects, including funding, quality assurance and protecting the title 'apprentice'.
- Engineering qualifications and enabling subjects: new GCSE and A-level content is being introduced, the English Baccalaureate is growing in influence, and the recruitment of trainee design and technology teachers is very low. All these areas have been covered by E4E in responses to government and Parliament.

- Careers guidance: the newly announced Careers & Enterprise Company will be an important part of the education landscape. E4E is working with organisations, such as Tomorrow's Engineers and STEMNET, to ensure that technical expertise is included.

Work to implement the recommendations of the 2013 *Perkins' Review of Engineering Skills* has focused on continuing professional development for teachers, work experience for students, engineering employer engagement in further education, and placements and other employer support for engineering higher education. E4E has worked with organisations such as the Engineering Professors' Council and the National Centre for Universities and Business to share information and practical guidance.

to create an Engineering Engagement Programme (EEP) aimed at attracting undergraduates from diverse backgrounds into employment in engineering. The Academy has hosted some 160 students on a combination of summer school and engineering fast-track workshops. Following positive feedback from both students and employers, the EEP will continue to run as a pilot for the next two years.

In November 2015, the Academy's Diversity Leadership Group (DLG) launched a toolkit developed with and for employers, *Increasing diversity and inclusion in engineering*, that features 17 case studies from 16 organisations to encourage greater diversity and inclusion in the profession. A benchmarking survey report in 2015 revealed that while many UK companies are already engaged in driving better gender balance in engineering, more work is needed in promoting ethnicity, sexual orientation and disability diversity. The launch event was attended by more than 100 stakeholders and publicised substantially on social media.

The Academy continues to work with InterEngineering and Stonewall to help attract, support and retain LGBT engineers in the workplace. In February 2016, the Academy co-sponsored an event at the House of Commons to mark the launch of a report, *Engineering Action: Tackling Homophobia in Engineering*, which is jointly authored by Alec Shelbrooke MP and Dr Mark McBride-Wright, chair and co-founder of InterEngineering. The report shows that over half of LGBT people in engineering are choosing not to disclose their sexuality through fear of homophobia and concerns about the impact on their professional careers of coming out. At the launch event, attendees were able to discuss the problem of homophobia and transphobia



Engineering students take part in a speed networking event at the Engineering Uncovered Summer School, the first phase of the Engineering Engagement Project



Delegates at the launch of the Academy's Diversity Toolkit

in the sector and ways in which engineering institutions could help eradicate it.

In March 2016, the Academy celebrated the women engineers in its Fellowship with

the launch of a page on its website to mark International Women's Day. Featuring profiles of 43 of the Academy's women Fellows, the project was well received and generated extensive media coverage.

Position engineering at the heart of society

The Academy's external affairs activities aim to position engineering at the heart of society by improving public awareness and recognition of the crucial role of engineers and by changing the language used to talk about engineering to better reflect its breadth and appeal.

Communications activities have grown steadily during the year, with an increase in media coverage, audiences engaged with the Academy through social media and readers of *Ingenia* magazine. A particular highlight was Chairman of the Queen Elizabeth Prize for Engineering Foundation and Past President Lord Browne FREng FRS's interview with Senior Fellow HRH The Duke of Edinburgh on BBC Radio 4's *Today* programme in January 2016. The Senior Fellow's comment that "everything not created by God was created by an engineer" was widely reported in national press, including a leader in *The Daily Telegraph* on the subject of how Britain should take pride in its engineering track record.

Past President Lord Browne FREng FRS talks to HRH The Duke of Edinburgh for BBC Radio 4's *Today* programme

Engaging through the media

Media coverage generated by the Academy continued to grow. This year, material produced by the Academy has appeared in print, on TV and radio, and online more than 3,000 times.

Over 250 news stories mentioned the New Year Honours for Fellows, in particular the President, Sir James Dyson FREng and Lord Darzi HonFREng, who were admitted to the Order of Merit. A leader in *The Times* described all three as 'richly deserving'.

Innovation is a central theme of Academy



MacRobert Award winners Artemis Intelligent Power receive their gold medal from HRH The Duke of Edinburgh and the President



Academy awards evening

In July 2015, the President was joined by over 400 guests to celebrate the best in UK engineering at the Academy's annual Awards Dinner. The event was held at the Landmark London and was attended by Fellows and leading engineers and their guests. The keynote address was delivered by His Excellency The Hon. Matthew Barzun, the US Ambassador to the UK.

The evening culminated in the announcement of the UK's most prestigious prize for innovation in engineering, the MacRobert Award. HRH The Duke of Edinburgh presented the prize to the winning team from Artemis Intelligent Power for the innovation of its Digital Displacement hydraulics power system.

A number of prizes were presented throughout the evening including the Silver Medals to three recipients who have made outstanding contributions to UK engineering (see page 11) and the Colin Campbell Mitchell Award, given to University College London's Optical Networks Group

for its pioneering contributions to optical communications technology. The Rooke Award was presented to Dr Hugh Hunt for his outstanding contribution to the public promotion of engineering through a wide and varied range of activities across education, television and radio.

The President's Medal was awarded to Sir Richard Olver FEng for his exceptional contributions to the Academy's work, particularly in engineering education. The Major Project Award was given to a team from Atkins for the delivery of the Highlands & Islands Superfast Broadband project.

communications. Dame Sue Ion DBE FEng introduced the finalists for the 2015 MacRobert Award on the *Today* programme and they received wide coverage including in outlets such as British Airways *Business Life* inflight magazine.

The Academy celebrated International Women's Day 2016 with promotion through social media of profiles of 43 female Fellows (see page 17). Dame Sue Ion was the castaway on BBC Radio 4's *Desert Island Discs* and the President wrote in *New Scientist* on the importance of recruiting more women to the profession.

The Academy policy study, *A critical time for UK energy policy*, received over 70 pieces of media coverage, including in the *Guardian*, the *Independent* and an appearance by David Clarke FEng on Radio 4's *Today* programme.

Dr Rhys Morgan, Director of Engineering and Education, became a presenter on Yesterday Channel's new series *Impossible Engineering*,

now in its second series with over 400,000 viewers.

The Academy's social media communities have also continued to grow, reaching over 13,000 followers on Twitter, more than 900 likes on Facebook and 6,900 followers on LinkedIn.

Public affairs

Following the 2015 general election, the Academy was proactive in meeting new ministers and their advisers, as well as members of both Houses of Parliament. Topics discussed included the comprehensive Spending Review, the engineering skills crisis and the contribution of engineering innovation to UK economic growth. In November 2015, the newly appointed Chair of the Commons Science and Technology Committee, Nicola Blackwood MP, visited the Academy to address the Trustee Board and former members of Council about her vision for her new role. In February 2015, the Academy held a meeting

with government chief scientific advisers to discuss shared goals and continue to build a productive working relationship.

The Academy joined the other national academies in hosting roundtable meetings at the Conservative, Labour and Scottish National Party conferences in September and October 2015. These events focused on the relevance of research and innovation to enhanced UK productivity, and were well attended by ministers, select committee chairs and other parliamentarians.

The Academy provided evidence to a number of select committee inquiries and government consultations. In May 2015, the Academy's Head of Policy, Dr Alan Walker, appeared before the Economy, Energy and Tourism Committee of the Scottish Parliament to discuss energy security. In July, Professor Ric Parker FEng and the presidents of the other national academies appeared in front of the Commons Science and Technology Committee to discuss the importance of



At a glance

Event highlights

May 2015

Cornflour, ketchup and parts for cars – East Midlands Regional lecture hosted by Loughborough University.

June 2015

Summer Soirée and Exhibition – 100 years of engineering excellence, hosted by Babcock International at Rosyth Dockyard in the presence of Royal Fellow HRH The Duke of Kent.

September 2015

Fellows' Day and 39th AGM – a special event for Fellows on the day of the 39th annual general meeting, highlighting the Academy's recent and current work.

October 2015

Innovation in agri-tech – showcasing a selection of some of the most recent advances in agri-tech.

November 2015

Creating underground infrastructure – the role of geotechnical engineering – Hinton Lecture delivered by Professor Lord Mair CBE FREng FRS.

Early development of the Rolls-Royce RB211 Turbofan engine – East Midlands Regional lecture by Philip Charles Ruffles CBE FREng FRS.

December 2015

In conversation with 2015 MacRobert Award Winners: Artemis Intelligent Power – pioneering new Digital Displacement® technology.

January 2016

Engineering forever – New Year Reception lecture given by Philippe Mellier, Chief Executive of De Beers Group.

March 2016

Health and safety: the journey back to common sense and personal responsibility – lecture by Dame Judith Hackitt DBE FREng as part of the *View from the top* series.

continued investment in UK research and innovation. In October 2015, Allan Cook FREng, Academy Vice President, appeared before the Department for Business, Innovation and Skills (BIS) Committee to discuss the relevance of engineering to UK productivity. In January 2016, Professor Parker gave evidence to the Lords Science and Technology Committee on the relationship between EU membership and the effectiveness of science, research and innovation in the UK. In February, the President attended a seminar of the Commons Science and Technology Committee to inform its submission to the March Budget.



Ingenia

The Academy's quarterly magazine *Ingenia* reaches a broad audience including school pupils, Fellows and opinion leaders. It is circulated in hardcopy to around 11,000 recipients, including opinion formers and all secondary schools that teach science in the sixth form, as well as being viewed 145,000 times online. The latest *Ingenia* readership

survey results found that each hard copy of the magazine is typically read by a further three people in addition to the subscriber, and 96% of readers rated the content as either good or very good.

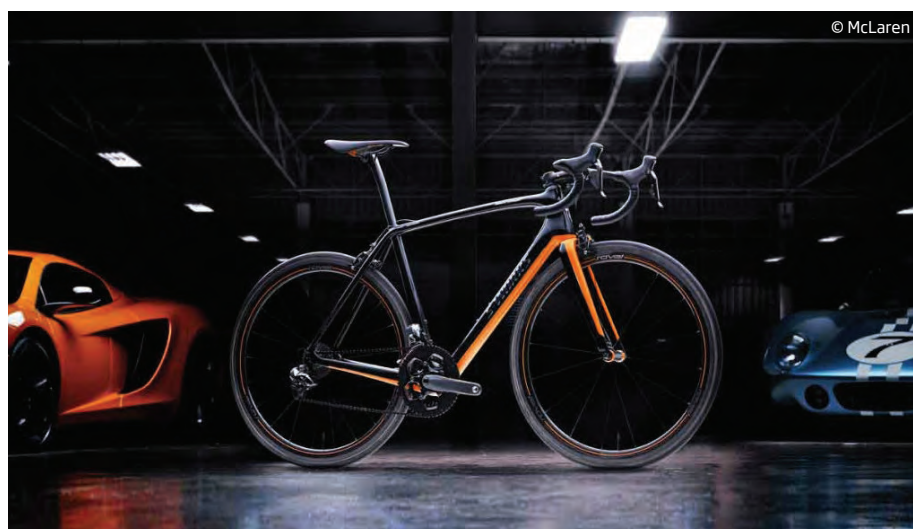
Ingenia publishes articles that cover the full spectrum of engineering and profiles of engineers across all disciplines. Over the past year, its articles have celebrated 50 years of tribology, explained how precision farming can increase the efficiency and yield of crops, and investigated what makes a good roller coaster.

The accompanying series of *Ingenia Live!* events, aimed at younger audiences, has covered a range of topics from the magazine. In November 2015, the second *Ingenia Live!* event explored how advanced engineering and novel materials are being used to make sports equipment faster, lighter and stronger. *Ingenia*'s Editor-in-Chief Dr Scott Steedman CBE FREng chaired the event, and the speakers were Dan Chambers, Co-founder and Director of Draft Wheelchairs Ltd., and Dr Caroline Hargrove, Technical Director of McLaren Applied Technologies.

Ingenious

The *Ingenious* public engagement grant scheme aims to develop engineers' communication and engagement skills by encouraging them to share their engineering stories, passion and expertise with members of the public in innovative ways. Funded by BIS since 2006, the scheme made awards to 23 projects in 2015.

Projects that ran over the last year ranged from location-specific initiatives that increased awareness of an area's engineering heritage to nationwide design competitions. One such project, *Back Then*, explored engineering in Sheffield's past and present through art. It brought together 20 engineers



This McLaren-designed bicycle is an example of how innovative engineering and materials are being used to create faster, lighter and stronger sports equipment, as discussed at *Ingenia Live!*

BIS exhibition: raising awareness of innovation

The announcements of the MacRobert Award finalists and winners have, for several years, been highlights in the Academy's communications calendar and present opportunities to raise awareness of innovation and the social impact of engineering. This year was no exception.

As well as widespread media coverage of the announcements, the MacRobert finalists also featured in a month-long exhibition in the foyer at BIS. The exhibition included a scale model of a wind turbine and an electronically controlled pump that showcased the Digital Displacement technology developed by MacRobert Award winner, Artemis Intelligent Power. Also featured was a working display from healthcare



Minister for Universities and Science, Jo Johnson MP, and the President view the MacRobert Award exhibition at BIS

company Endomag, which is responsible for pioneering the development of an alternative method of breast cancer diagnosis. The third stand demonstrated the properties of Victrex's ACTIV film, which has made smartphone speakers smaller and thinner without compromising reliability or sound quality. ACTIV film is now used in 70% of smartphone speakers worldwide.

Visitors to the exhibition in the BIS foyer over the month of June 2015 included policymakers, representatives from industry and the Minister for Universities and Science Jo Johnson MP. The display emphasised how the Academy and BIS work closely together to promote growth through UK-based innovation.

and five community groups, including a parents' group, a primary school and residents in sheltered housing, to curate an exhibition of photography, painting and sculpture that explored the impact of engineering on the local community and the challenges it might help them address in the future.

Ingenious also funded the UK Space Design Competition, which gave secondary school students the opportunity to take part in a design simulation working in a large industrial team. Students were tasked with designing a space settlement for up to 10,000 inhabitants, taking into account factors such as structural engineering, entertainment and food production.

The *Ingenious* scheme continues to be the lead public engagement scheme in the profession. Results from the most recent long-term tracking survey of engineers who participated in *Ingenious* projects show that, while 46% had no prior public engagement experience, almost 70% had gone on to participate in additional public engagement activities after taking part in the scheme.



A visitor enjoys the *Ingenious*-funded Back Then exhibition, which explored Sheffield's engineering heritage



FEATURED FELLOW

Dame Judith Hackitt DBE FEng, Chair of the EEF, was appointed Chair of the External Affairs Committee and delivered a *View from the top* lecture about her involvement in re-establishing the reputation of the Health and Safety Executive, where she was Chair for eight years.



Dr Robert Langer receives the Queen Elizabeth Prize for Engineering trophy from Her Majesty The Queen at a ceremony at Buckingham Palace

Celebrating engineering – Queen Elizabeth Prize for Engineering

The Queen Elizabeth Prize for Engineering is an international £1 million prize that rewards and celebrates engineers responsible for a groundbreaking innovation that has been of global benefit to humanity.

In February 2015, the judges announced that the 2015 Queen Elizabeth Prize for Engineering (QEPrize) would be awarded to Dr Robert Langer, a chemical engineer who has made revolutionary advances and is a world leader in engineering at the interface with chemistry and medicine.

The award of the second QEPrize generated remarkable international media coverage from outlets including the wider BBC networks, *The Times*, the *Washington Post*, *China Daily* and the *Times of India*. Together, this media activity has brought news of the QEPrize to a global audience of more than 1.25 billion people.

Dr Langer received the QEPrize trophy

from HM The Queen in October 2015 during a ceremony at Buckingham Palace. The ceremony attracted international representation, with ambassadors and high commissioners from countries including the United States, China, Japan, Germany, South Korea, South Africa, Singapore and India in attendance. They were joined by senior business leaders from the QEPrize donor companies, including BG Group, GSK, Jaguar Land Rover, National Grid, Nissan, Sony, Tata Steel, Tata Consultancy Services and Toshiba, and young engineers from the QEPrize Engineering Ambassadors Network.

The day also marked the release of the first QEPrize report, *Create the Future*. The report revealed the changing nature

of perceptions of engineering across 10 key markets, including the USA, Germany, Japan, Turkey, India and Brazil, and provided insights into the differences in these perceptions between countries. The report also featured expert commentary from leaders in the fields of commerce, science, academia, and the full breadth of engineering disciplines.

Engagement with the 13 QEPrize donor companies continued throughout the year. Some 100 guests attended an evening audience with the Chief Executive of Siemens, Juergen Maier, and keynote interviews have taken place with the leaders of BP, Shell and BAE Systems.

Lead the profession

The Academy's engineering policy activities are focused on five strategic priority areas: energy and environment; infrastructure and transport; manufacturing; biomedical engineering and healthcare; and digital systems.

Each of these policy areas is considered to be essential and work has either been completed or is ongoing in all of them. Alongside these areas, work that supports the Academy's overall strategy is also undertaken, as well as a specific role in advising government in policy areas related to engineering. The Academy has close links with BIS, the Government Office for Science (GO Science) and the Department of Energy and Climate Change (DECC).

Infrastructure and transport

This year, two significant reports were published on the infrastructure and transport sectors. The first was the report *Built for living*, published in July. Produced jointly with Arup and the Economic and Social Research

Council with support from the Royal Institute of British Architects (RIBA), University College London and the University of Leeds, this report explored the relationship between the design of the built environment and human behaviour, as well as the implications for design practice, research and policymaking. It followed a series of three workshops, hosted by the Academy, RIBA and Arup, that explored ways in which the design of the built environment can have a significant impact on resource use (in particular, energy, water and waste), health and wellbeing, and performance and productivity.

The report highlighted how design and human behaviour are interlinked and that stakeholders need to collaborate to capitalise on what is already known about both.

An Arup Realtime synthetic environment simulates navigation of a railway station



© Alvise Simondetti, Arup



At a glance

Responses to consultations and inquiries

April 2015

Response to the *Nurse review of research councils*.

July 2015

Responses to the House of Commons Environmental Audit Committee on the environmental risks of fracking and the British Academy's Consultation on Interdisciplinarity.

August 2015

Responses to the House of Commons Energy and Climate Change Committee on priorities for holding government to account and the House of Commons Science and Technology Committee on the science budget.

September 2015

Response to the House of Commons Science and Technology Committee on the big data dilemma, an *Engineering the Future* response to the Business, Innovation and Skills Select Committee on the government's productivity plan, and a joint academies submission to the Migration Advisory Committee's Review of Tier 2.

November 2015

Response to the House of Lords Science and Technology Committee on the relationship between EU membership and UK science.

January 2016

Response to BIS on higher education: teaching excellence, social mobility and student choice.

February 2016

Responses to the House of Commons Business, Innovation and Skills Committee inquiries on access to finance and on the proposed integration of Innovate UK into Research UK. A joint academies letter to government regarding recommended changes to the Tier 2 visa route.

March 2016

Response to Lord Stern's Review of the Research Excellence Framework Submission.

Digital systems

In 2015, the Academy focused on the subject of digital systems, an increasingly vital sector of the economy with impact across all areas of engineering.

Connecting data: driving productivity and innovation was a joint report between the Academy and the Institution of Engineering and Technology, published in November 2015. It explored how the UK can create a 'data-enabled' economy through the use of data analytics (more colloquially 'big data'), supported by data science and advanced data connectivity. It was based on evidence from stakeholder workshops that were run between November 2014 and June 2015 for seven sectors: advanced manufacturing; built environment; energy; transport; health; aerospace and defence; and insurance.

The findings suggested that the area is still largely immature, but has pockets of excellent practice. The UK is strongly placed to develop a leading data-enabled economy, although it will need to address barriers to remain competitive internationally. Recommendations include: the deployment of best engineering practice to new areas such as software development; investment in broadband services equivalent in

A number of ways to improve design outcomes were suggested, including that design should be undertaken from a systems viewpoint. It recommended that user input should be sought from the start of the process, and that a multidisciplinary team including designers, social scientists and engineers should work together using an iterative process, with interdisciplinary feedback. Case studies within the report illustrated the various research methods, tools and techniques that can be used to inform or support this kind of approach to the design of the built environment.

Transport congestion was the subject of the Academy's first 'challenge paper'. This is a new format that allows Academy Fellows with particular expertise to explore challenging issues of interest, and then produce an evidence-based expert view on an issue where consensus on a policy position might prove difficult to achieve.

The resulting paper, *The transport congestion*



performance to EU targets; investigation of methodologies that allow the value of data assets to be formally recognised; the development of appropriate industry standards; and the exploration of mechanisms for creating markets in data. To facilitate this, it will be important to share best practice and nurture the relevant multidisciplinary skills, in order to address the severe shortage of engineers with data science skills and specialist data scientists.

Work continues to build on the findings of this report, particularly in the areas of cyber safety and resilience, and the valuation of data.

challenge, addressed the growing problem of congestion on the UK's road and rail networks. It assessed the technical practicality of various measures to get more out of them, either to buy time before new infrastructure can be delivered or as the most effective means of optimising existing capacity. Led by a number of Fellows who are experienced transport practitioners and academics, it focused on the costs and congestion reduction potential of the different measures and identified 18 'frontrunners' that offer the best value for money.

It recommended that government should develop an integrated strategy for tackling road and rail congestion, and that such a strategy must maximise the impact of any measure by carefully packaging different technologies and policy measures together. It found that, of all the available interventions considered, efficient pricing on the road network offered the single best way of tackling congestion. The paper recognised that this was not currently in favour with policymakers or the public, but that a well-

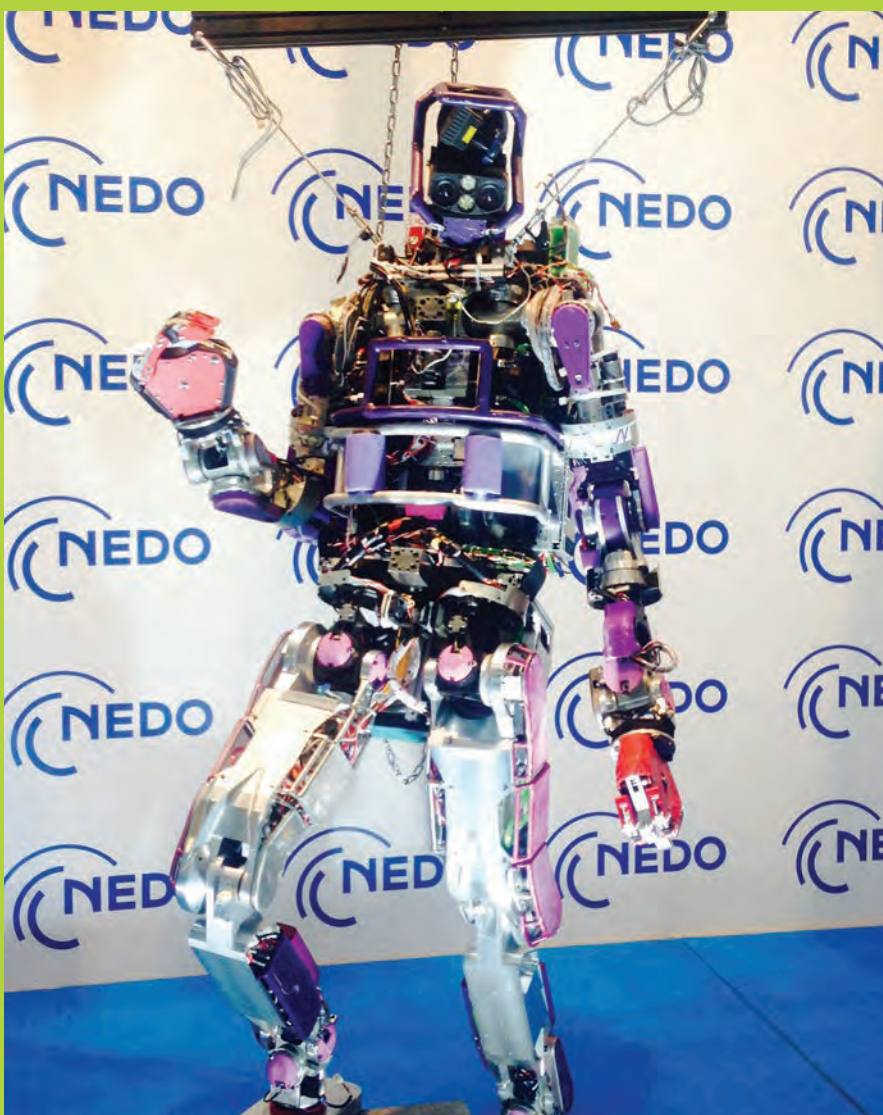
International activities

The Academy has been involved in a wide range of activities across the world, working with national academies, international governments and commissions, and even mixing with global superstars. This activity has seen it influence international and European policy, and contribute to engineering solutions to worldwide challenges.

Last year, the Academy extended its policy reach internationally through a number of missions and events, including an innovation workshop in China on the theme of advanced manufacturing; a robotics mission to Japan jointly organised with UK Trade & Investment; and an inward visit from the Korean National Academy of Engineering on the theme of encouraging technology entrepreneurship that coincided with the Academy's Enterprise Hub open day. In June 2015, the Academy led a UK delegation to a high-level symposium on air quality in Beijing, as part of its ongoing collaboration on the issue with the Chinese government. This has influenced the scope and purpose of Chinese legislation.

Through its membership of the European federation of national engineering academies, Euro-CASE, the Academy also helped facilitate the creation of a new European Science Advice Mechanism. This aims to provide the European Commission with transparent advice that is independent of institutional or political interests, brings together evidence and insights from different disciplines and approaches, and takes into consideration the specificities of EU policymaking. Euro-CASE and four other partner networks of science academies will be integral to this new mechanism.

In September 2015, eight Academy Fellows and awardees spoke at the second Global Grand Challenges Summit, hosted by the Chinese Academy of Engineering in Beijing. This is part of a three-year collaboration between the UK, USA and Chinese national academies on the contribution that engineering can make to meeting common global challenges. Highlights of the event included Enterprise Fellow Jack Cohen discussing his virtual reality innovation on a panel alongside musician and technology enthusiast will.i.am.



Advanced robotics technology on display during the Academy's robotics mission to Japan with UK Trade & Investment



Enterprise Fellow Jack Cohen (second from left) shares a panel that includes musician will.i.am, at the Global Grand Challenges Summit in Beijing

designed system could attract popular support and achieve substantial reduction in levels of congestion.

Both these reports were well received and work continues to develop their main themes.

Manufacturing and industry

Policy work in the area of manufacturing and industry focused on innovation and enterprise. Two events were held focusing on **innovation**: *Innovation in autonomous systems* in June 2015 and *Innovation in agri-tech* in October 2015. Both were well attended and featured presentations from those currently active in bringing innovations to market in the respective fields.

The case for continued investment in the UK research base as a means of fuelling future prosperity was the subject of the *Investing in innovation* report launched in September 2015. This report highlighted the need to focus on UK innovation investment and performance in order to ensure that the most is made of the potential in the research base and that the UK can continue to compete globally. It concluded that a clear and robust commitment to targeted, coherent and stable support – both direct and indirect – is essential if the government is to meet its ambition to tackle the productivity challenge and secure the UK's position as one of the richest economies in the world.



The report *A critical time for UK energy policy* looked at what was needed to secure a sustainable future energy supply for the UK, including low-carbon electricity-generating technologies such as offshore wind power

Energy and environment

In October 2015, the report *A critical time for UK energy policy: what must be done now to deliver the UK's future energy system* was launched. This was the third in a series of studies on energy for the Prime Minister's Council for Science and Technology.

The report assessed the actions needed now to secure a sustainable future energy supply for the UK. By considering what the models suggest as the most likely evolution of the system and how this compares with the expectations of industry stakeholders, the working group laid out what it saw as the main risks to delivering against the energy 'trilemma': cost, security and decarbonisation. Overall, it was found that delivery of the UK's future energy system is under serious threat. Substantial investment is needed, costs are likely to rise and decarbonisation must be realised across multiple interconnected sectors where the full technical solution is not yet obvious. The main recommendations are to:

- undertake local or regional whole-system, large-scale pilot projects to establish real-world examples of how the future system will work
- drive forward new capacity in the three

main low-carbon electricity-generating technologies: nuclear, carbon capture and storage, and offshore wind

- develop policies to accelerate demand reduction, especially in the domestic heat sector
- clarify and stabilise market mechanisms and incentives in order to give industry the confidence to invest.

Healthcare and biomedical engineering

The healthcare and biomedical sectors are significant areas of interest for the Academy. Through the Panel for Biomedical Engineering, a multi-institution committee hosted by the Academy, there is a programme of work that includes a biennial two-day event for early-career researchers to showcase their work with opportunities for mentoring and guidance on scientific and professional opportunities from selected experts. The next event will be at Imperial College London on the subject of *Medical imaging and interventions: engineering a better look at cancer*.

The Academy has begun a major study that will consider how engineering systems thinking can help to deliver greater efficiency



Professor Jim Norton FEng, board member of UK Parliamentary Office of Science and Technology and special adviser to the Culture, Media and Sport Select Committee, is a member of the Engineering Policy Committee and was the lead author of the *Connecting data* report.

FEATURED FELLOW



An Academy study into how engineering systems thinking can help deliver greater efficiency in UK healthcare aims to show how engineering can contribute to addressing the challenges of limited resources and budget within the health and social care sector

within the UK's health and social care system while it faces growing resource challenges and a limited central budget. It is hoped that

this study will show how engineering can contribute to addressing one of the major challenges facing society today.

Engineering the Future

Engineering the Future (EtF) is the name of the overarching programme hosted by the Academy to bring together the professional engineering institutions (PEIs), the Engineering Council, and EngineeringUK on key areas of policy. One strand of this work is Education for Engineering (see page 17), while another is focused on the overall policy environment for engineering.

EtF's work on engineering policy addresses complex areas such as energy, transport, climate change, flooding, big data, and innovation. Wherever possible, the PEIs come together under EtF and agree common positions on these important areas that are of great importance to society.

In the past year, there has been a great deal of focus on the government Spending Review and the potential impact of changes to funding. EtF submitted information to the Treasury ahead of the Spending Review that articulated how engineering contributes to the whole of the UK economy and to each of the government's Spending Review priorities. The government is looking for ways to improve efficiency in areas such as local government and the health service, and engineering can provide both the technical support and the 'habits of mind' necessary to achieve this. The EtF submission made a

strong case for government spending that supports engineering as a key enabler for government priorities.

Following the publication of *The Universe of Engineering: A call to action* in October 2014, the EtF group has taken each of the recommendations and formulated action to address them. Some are covered by other initiatives, such as the Engineering Talent Project (see page 15), while others require PEIs to give serious consideration to their membership offer and how they work with other organisations. This work is being coordinated through EtF, with individual organisations leading on particular recommendations. The Chair of EtF, Sir Terence Morgan CBE FREng, is active in many industry and education groups that are also involved in government initiatives, giving EtF a valuable insight into emerging priorities and issues.

Greatly enhance the Academy's delivery capability

Prince Philip House building plans

In early 2016, the final phase of the refurbishment of Prince Philip House began. Work started on remodelling of the basement and mezzanine to accommodate the Enterprise Hub in a contemporary environment conducive to the mentoring and networking activities of the Academy's enterprise programmes. Wright & Wright, the Academy's architect, produced some exciting designs for a practical space based on the Academy's needs. At the same time, a modern kitchen will be installed to replace the

current facility, which is almost 30 years old. Building work will be completed by the end of November and the new kitchen will be in place by Christmas 2016.

Development

In the last year, the Academy secured £2.8 million in new commitments for education, engagement, enterprise and research programmes. Support came from corporates, charitable foundations and individuals, including Fellows. The continuing



An artist's visualisation shows how the lower ground floor will look after the redevelopment of Prince Philip House



Richard Williams, Vice President of Fellowship Engagement

The Fellowship is the heart of the Academy and a better level of engagement with a greater number of Fellows serves to advance the Academy's aims and strategic objectives.

Professor Richard Williams OBE FREng, Principal and Vice-Chancellor at Heriot-Watt University, became the first Vice President for Fellowship Engagement in September 2014, following a comprehensive review of the Academy's governance structure and procedures.

Professor Williams has since initiated and led a number of Fellowship-focused activities.

An all-Fellows survey was conducted in spring 2015 to garner Fellows' views and suggestions on Fellowship engagement. This identified a number of areas that the Trustee Board will address, including the

imperative for the Academy to ensure its primary role to lead the national debate on engineering policy and the economy even more strongly.

Broadening the regional footprint of Academy activity is a key strand of Fellowship engagement that is also being addressed. The Academy piloted a regional champions model, whereby Fellows around the country would be supported in organising activities in their local area. This has already successfully been introduced in the East Midlands, South West and the North East, with future regional activity taking place in the North and North West of England.

Regular lunches for Fellows are now held all over the UK so that Fellows outside London can participate more easily in supporting, and engaging with, the Academy.

The first Academy Fellows' Day at Prince Philip House in September 2015 attracted great interest from the Fellowship. It enabled Fellows to see the work being undertaken by other Fellows and Academy staff to advance and promote engineering. It also gave them the opportunity to meet the Trustees and staff in a more informal setting, and to network with one another.

generosity of all donors and supporters is greatly appreciated, as is the assistance of the Development Advisory Board, chaired by Ian Barlow.

International programmes received major support during the year: the Anglo American Group Foundation awarded a multi-year grant to expand the Academy's work in sub-Saharan Africa to improve engineering teaching standards and strengthen links between industry and academia; and the UK

Foreign and Commonwealth Office supported enhanced training for the Africa Prize for Engineering Innovation finalists. In the UK, six major engineering employers – Airbus, Babcock International, BAE Systems, GKN, Jaguar Land Rover and National Grid – all provided support for the Engineering Talent Project, which the Academy is coordinating.

Petrofac provided additional support to expand the Academy's *Connecting STEM Teachers* network, which is now active in

some 15% of all UK secondary schools. The Sir John Fisher Foundation supported the Academy's STEM support programme in Barrow-in-Furness for a fourth consecutive year, and a grant from The Ogden Trust helped launch a similar initiative in Lowestoft. These regional support programmes aim to encourage more young people from a diverse range of backgrounds to become engineers. In further education, the Motorola Solutions Foundation made possible a new round of female Visiting Teaching Engineers to help



At a glance

Examples of new funding

Enterprise

The Royal Commission for the Exhibition of 1851 provided funding for three Enterprise Fellowships per annum for engineering graduates.

Research

A Welsh National Research Network supported industrial secondments for engineering academics.

Education

Motorola Solutions Foundation granted funding for additional female Visiting Teaching Engineers in further education colleges.

Awards

The Worshipful Company of Engineers provided funding for five awards to early-career engineers demonstrating excellence.

International

The Anglo American Group Foundation awarded a further multi-year grant to improve engineering higher education in sub-Saharan Africa.

Annual Fund

Gifts from Fellows were allocated to three priority areas: international projects, Enterprise Hub and regional STEM education projects.

provide teaching support and mentoring in sixth forms and colleges, and act as valuable role models for women seeking to enter the engineering profession.

During the year, Schlumberger and Mathys & Squire LLP joined the Enterprise Hub's partnership programme, which along with Fellows' pro-bono support is helping to enhance and expand the Hub's activities.

Generous support from John Taylor FREng and a legacy from the late Geoffrey Argent FREng are helping create the dedicated facilities for the Enterprise Hub on the lower ground floors at Prince Philip House, illustrating the transformative impact major gifts can have on the Academy's development. The Academy has also launched *Build a Better World*, an initiative to develop legacy giving in the Fellowship that, together with lifetime giving, will help the Academy build on progress and achieve its ambitions.

Trading company

RAE Trading Limited (RAET), the Academy's trading subsidiary, provides high-quality catering for the Academy's events and meetings in Prince Philip House. RAET also markets Prince Philip House as an events venue primarily to the corporate sector. The company's success has continued into its third year and it generated revenues of £1.5 million from which it will gift aid more than £400,000 to the Academy. RAET has temporarily ceased trading during the final phase of the development of Prince Philip House but will reopen in January 2017 with the significant benefit of a new kitchen.



© Aerograft

Aerograft, a spin-out company from University College London supported by the Enterprise Hub, has developed a novel bone graft substitute that could transform dentistry, enabling new bone graft substitutes to integrate into chipped or damaged teeth and potentially achieve 95% integration with the surrounding bone in just three months



FEATURED FELLOW

Malcolm Brinded CBE FREng, Chairman of the Shell Foundation, is chair of the Africa Prize for Engineering Innovation and an active member of the International Committee and the Development Advisory Board.

New Fellows 2015

The Academy's Fellows represent the nation's leading engineering researchers, innovators, entrepreneurs, and business and industry leaders. Each year 50 Fellows are elected by peer review from nominations made by existing Fellows. They are distinguished by the title Fellow of the Royal Academy of Engineering and the postnominal FREng. These were the new Fellows announced at the Academy's AGM in September 2015; their titles were correct at the time of their election.

Fellows



Professor Claire Adjiman FREng

Co-Director, Institute of Molecular Science and Engineering; Professor of Chemical Engineering, Imperial College London



Chris Allam FREng

Engineering and Programme Management Director, BAE Systems, Military Air and Information



Timothy Burnhope FREng

Chief Innovation and Growth Officer, JCB Group



Professor David Butler FREng

Professor of Water Engineering, University of Exeter



Professor Darwin Caldwell FREng

Research Director, and Director, Advanced Robotics Department, Italian Institute of Technology



Ivor Catto FREng

Independent consultant



Peter Chapman FREng

Barrister and arbitrator



Professor Anthony Cohn FREng

Professor of Automated Reasoning, University of Leeds



Professor Paul Collier FREng

Head, Beams Department, CERN



Professor Bob Cryan FREng

Vice-Chancellor and CEO, University of Huddersfield



Professor John Daugman FREng

Professor of Computer Vision and Pattern Recognition, University of Cambridge



Professor Rene de Borst FREng

Regius Professor of Civil Engineering and Mechanics, University of Glasgow; Consultant, Dassault Aviation, Paris



Vincent de Rivaz FREng

Chief Executive, EDF Energy



Professor Mohan Edirisinghe FREng

Bonfield Chair of Biomaterials, University College London



Professor Colin Garner FEng

Caterpillar-Royal Academy of Engineering Chair in Applied Thermodynamics, Loughborough University



Richard Goodwin FEng

Managing Director, Goodwin plc



Steve Harridge FEng

Consultant, Tony Gee and Partners LLP



Dr Chris Haynes FEng

Project Assurance Consultant, KazMinerals plc; Non-Executive Director, Woodside Petroleum Ltd, Perth and Non-Executive Director, WorleyParsons Ltd, Sydney



Dr Clive Hickman FEng

Chief Executive, Manufacturing Technology Centre (MTC)



Professor Karen Holford FEng

Pro Vice-Chancellor, Head of College of Physical Sciences and Engineering and Professor of Mechanical Engineering, Cardiff University



Dr Rick Jefferys FEng

Senior Research Director, University of Edinburgh; formerly Director of Strategy and Technology, ConocoPhillips, Alternative Energy



Dr David Knowles FEng

Director, Energy, Atkins



Bernard Looney FEng

Chief Operating Officer, Production, BP plc



Paddy Lowe FEng

Executive Director (Technical), Mercedes Benz Grand Prix Ltd



Jonathan Lyle FEng

Chief Executive, Defence Science and Technology Laboratory (Dstl)



John Mair FEng

Technology Director, Corporate, Subsea7



Colin Matthews FEng

Chairman, Highways England



Professor Barrie Mecrow FEng

Head of School, School of Electrical and Electronic Engineering, Newcastle University



Andy Mitchell FEng

Chief Executive Officer, Thames Tideway Tunnel Ltd



Dr Edward Morton FEng

Chief Technical Officer, Rapiscan Systems Ltd



Professor Robert Parkin FEng

Pro-Vice Chancellor (Research and Knowledge Transfer), University of Bradford



John Reece FEng

Chairman, Reece Group; Trustee, Reece Foundation; Trustee, Springfield House Trust



Professor Stephen Roberts FEng

Professor of Machine Learning, University of Oxford



Professor Daniel Rueckert FEng

Professor of Visual Information Processing, Department of Computing, Imperial College London; Consultant, IXICO; Scientific Adviser, Vision RT



Professor Mary Ryan FEng

Professor of Materials Science and Engineering, Imperial College London



Richard Sadler FEng

Company Director, RLS Fidelis Ltd



Professor Angela Sasse FREng

Professor of Human-Centred Technology and Director of the Science of Cyber Security Research Institute, University College London



Professor Nilay Shah FREng

Professor of Process Systems Engineering, Centre for Process Systems Engineering (CPSE), Department of Chemical Engineering, Imperial College London



Professor Constantinos Stavrinidis FREng

Head, Mechanical Engineering Department, European Space Research and Technology Centre, European Space Agency



Patrick Thomas FREng

Chairman and Chief Executive, Covestro



Professor Mark Tooley FREng

Head of Medical Physics and Bioengineering, Director of Research and Development and Consultant Clinical Scientist, Royal United Hospitals Bath NHS Foundation Trust; Visiting Professor, University of Bath and University of the West of England



Dr John Tubman FREng

Managing Director, Management Services and Defence, UK, Ireland and Continental Europe, AECOM



Professor Florin Udrea FREng

Professor, University of Cambridge; Chief Technical Officer, Cambridge Microelectronics Ltd and Cambridge CMOS Sensors



Professor David White FREng

Shell EMI Chair in Offshore Engineering, University of Western Australia, Perth



Ant Wilson FREng

Director, Sustainability and Advanced Design – Building Engineering, AECOM UK



Professor Michael Wisnom FREng

Professor of Aerospace Structures, University of Bristol; Director, Advanced Composites Centre for Innovation and Science (ACCIS); Director, Rolls-Royce Composites UTC



Professor Hua Zhao FREng

Vice Dean (Research) and Professor of Mechanical Engineering, College of Engineering, Design and Physical Sciences, Brunel University London

International Fellows



Dr Robert Care FREng

Principal, ACT and Strategic Geographies Leader, Arup Australasia



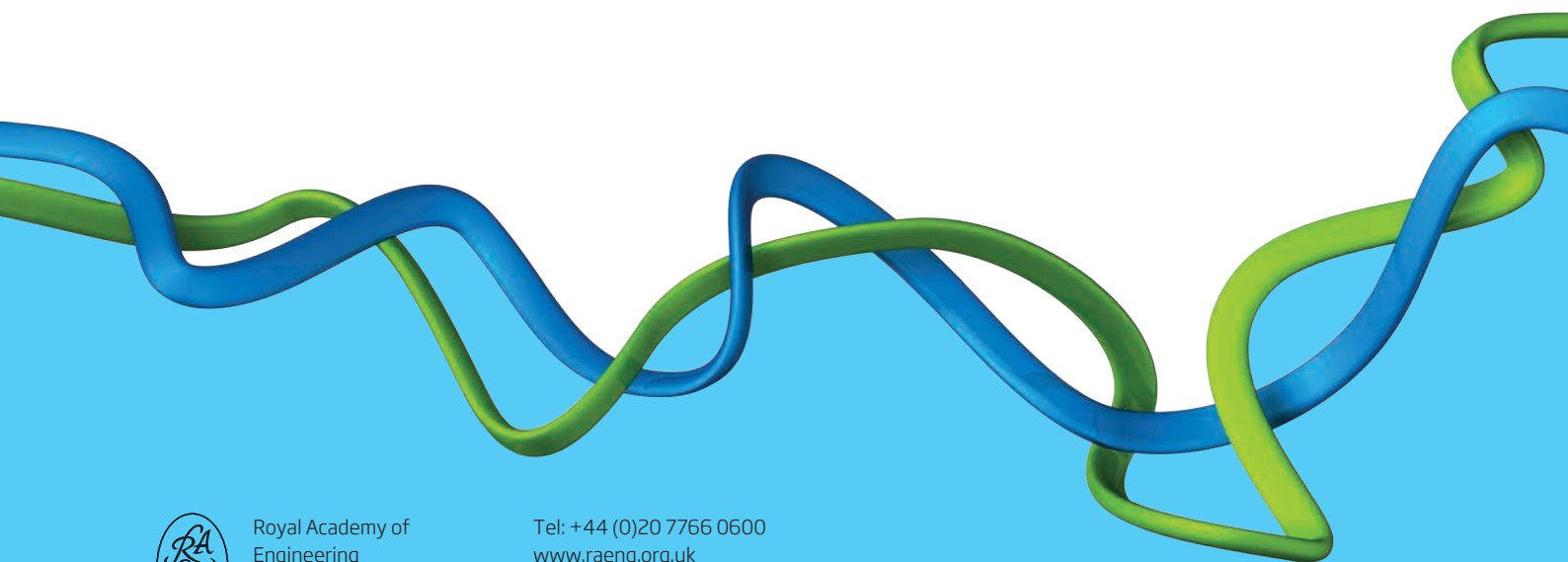
Professor Manfred Morari FREng

Professor of Automatic Control, Department of Information Technology and Electrical Engineering, ETH Zurich



Professor Scott Sloan FREng

Director, ARC Centre of Excellence for Geotechnical Science and Engineering, Newcastle University, Australia



Royal Academy of
Engineering
Prince Philip House
3 Carlton House Terrace
London SW1Y 5DG

Tel: +44 (0)20 7766 0600
www.raeng.org.uk
Registered charity number
293074



Please recycle this brochure (the cover is treated with a recyclable laminate)