



Lloyd's Register
Foundation

Foundation Review 2015

Connecting
science, safety
and society

Life matters





The Lloyd's Register Foundation is a charity that helps to protect life and property and support education, engineering-related research and public engagement.

Our vision is to be known worldwide as a leading supporter of research, training and education – relevant to the field of engineering – which makes a real difference in improving the safety of the critical infrastructure that is vital to modern society. To support this, we promote scientific excellence and act as a catalyst working with others to achieve maximum impact.

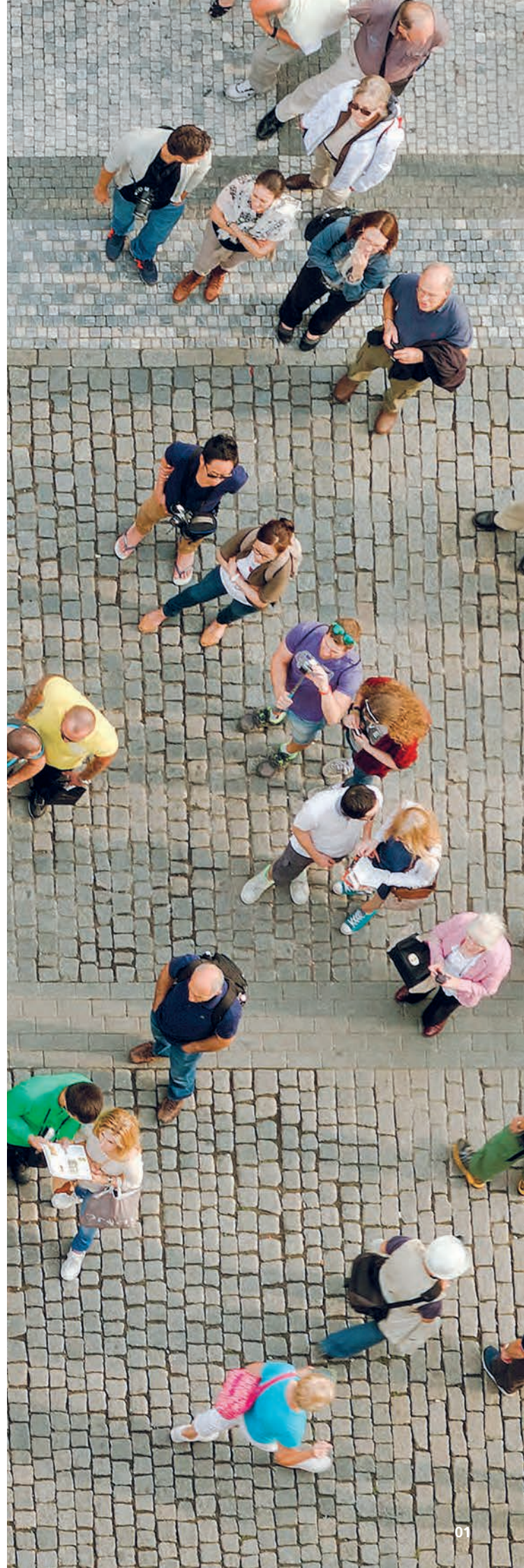
We do this because life matters

KEY HIGHLIGHTS

- Committed £9 million of grants for nanotechnology research and education
- Published foresight review on big data and commissioned two more reviews
- Conditional grant offer to the Alan Turing Institute for the engineering applications of big data, with finalisation of the contract in 2015/16
- Funded UK skills shortage research by the Royal Academy of Engineering

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AT A GLANCE

Connecting science, safety and society

OUR VISION

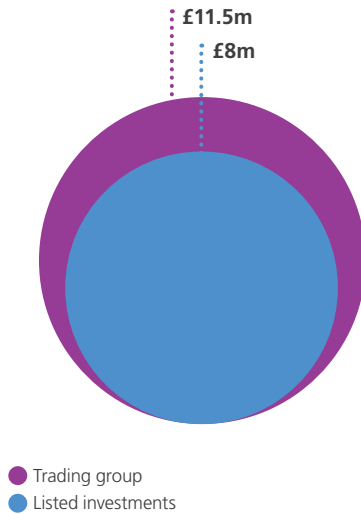
The Lloyd's Register Foundation is a charity and owner of Lloyd's Register Group Limited (LR), a 255-year-old professional services company. With our mission to protect the safety of life and property, and to advance transport and engineering education and research, the Foundation has an important role to play in meeting the challenges of today and the future.

We meet our aims by awarding grants, by direct activity and through the societal benefit activities of LR, which shares our mission.

Through our grant making we aim to connect science, safety and society by supporting research of the highest quality and promoting skills and education.

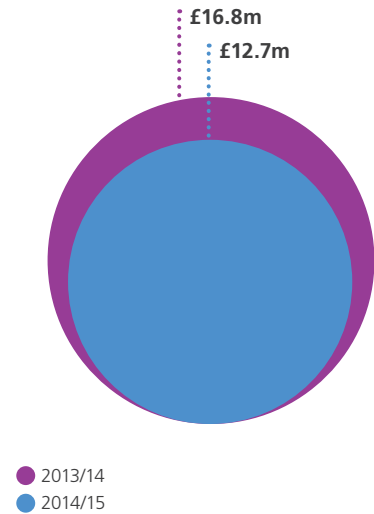
Foundation income by source 2014/15

£19.5m



Value of grants awarded 2013/14 and 2014/15

Note: a £10m grant was awarded just after the year end



Charitable expenditure by strategic theme 2014/15

£14.5m

Charitable expenditure consists of £12.7m of grants awarded, £0.7m of direct costs and £1.1m of support costs

89%

Supporting excellent scientific research

<1%

Accelerating the application of research (£22,000)

7%

Promoting advancement of skills and education

4%

Promoting safety and public understanding of risk

Applications and grants 2014/15

224

Approaches for funding

35

Grants awarded

17

Beneficiaries are from 17 countries around the world

£36m

Total 'value' of grant portfolio as at 30 June 2015

MAKING AN IMPACT IN 2014/15



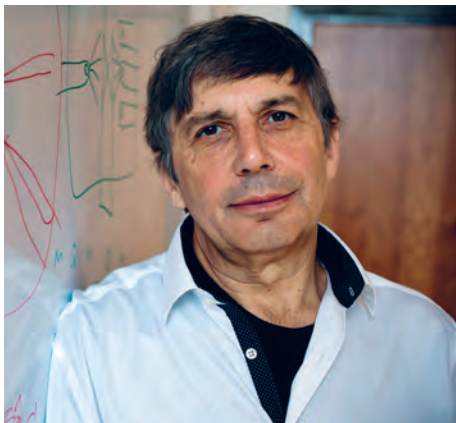
We plan to exploit the breakthrough discoveries made ... over the last 5–10 years and endeavour into unknown territories ...

On nanotechnology

**Prof Sir Andre Geim,
University of Manchester**

2nd

year of operation as
Lloyd's Register Foundation



22

academic awards recognising
the excellence of our
funded researchers



300+

papers, chapters and
books published by our
funded researchers



715,500

people directly engaged in
STEM enrichment activities
through our funding



1,000+

young people at a summit
on water conservation and
management in South Africa



The Foundation has recognised
the value of becoming an early
investor in an area with huge
potential to transform
engineering and create
benefits for humankind.

On big data

Prof Patrick Wolfe, UCL



Win-win

A funded PhD researcher's
system for detecting pipeline oil
leakage benefits business and
the safety of local populations

CHAIRMAN'S STATEMENT

Building from a solid base



In only a very short space of time we have grown the Foundation into a major grant giver but believe this is only the start.



As technology continues to develop and the population continues to expand, the Lloyd's Register Foundation continues to grow its capabilities and ability to help make society a safer place for all. It fulfils its core objectives of enhancing the safety of life and advancing public education through undertaking high-quality engineering-related research and through its education-related grant-giving programme. We believe that as the pace of technological change increases, the Foundation will have a unique and important job to fulfil.

Our second full year of operation

Our first year was one of considerable change as we sought to put the governance, people and systems in place in order to allow the Foundation to start its programme of activities to help address society's needs. We believe we managed to build a solid base for future growth, as I reported last year.

This, our second full year of operation, has seen us move away from these internally focused structural-type considerations, allowing us instead to concentrate on our grant-making activities, including growing relationships with beneficiaries and others in the charitable sector. We are hugely proud of what we have achieved during the year, as more fully explained in the Managing Director's report and the pages that follow. However, I will take this opportunity to highlight a couple of key matters.

As a young charity it is important to learn from other well-respected organisations and in this spirit we have sought to develop relationships and learn from other global charities similar to ourselves. Discussions have taken place at the operational level as well as between trustees with other organisations. In subsequent years this is definitely something we intend to build on, exploring areas of common interest.

Having drawn up and agreed a strategy last year, we have continued to develop our four strategic themes through foresight reviews. By bringing together world experts we have been able to identify opportunities for the Foundation in the fields of nanotechnology and big data thereby allowing us to focus our requests for proposals.

We have also been working with the founder members of the Alan Turing Institute, being established with support from the UK government, to see whether the Institute would benefit from the Foundation's support relating to the engineering aspects of big data. A firm commitment has now been agreed and was concluded after the close of the year.

We have supported many educational projects during the year, including working with the Royal Academy of Engineering in mapping out the STEM (science, technology, engineering and mathematics) landscape in the UK, to see where resources can best be used.

We have developed an approach to peer review the various proposals we receive and in the coming year we will recruit additional staff to help us deliver our growing programme of works.

Our trading group, Lloyd's Register Group Ltd (LR), continues to deliver services that make a significant contribution to the performance of our charitable objective in relation to the enhancement of the safety of life and property. We also benefit from the monies which are gifted to us by our trading group. The relationship we enjoy is unique in the sector and allows us to learn from real-life engineering issues as to where and how we can better help society.

We look back on the past year with pride and a great sense of achievement. In only a very short space of time we have grown the Foundation into a major grant giver but believe this is only the start. We look forward enthusiastically to seeing what the Foundation can further achieve now that it has both a solid base and a sense of momentum.

Supporting the Foundation

Throughout this year of consolidation and growth, we have been ably supported and guided by the six trustees of the Foundation, who have continued to give their time and expertise and help bring further benefits to society. In addition to his role as a trustee, I should especially like to thank Lambros Varnavides for so ably chairing the Foundation's Grants Committee, as it assesses and recommends funding proposals to the Board.

The Foundation would not have developed as quickly as it has without the clear guidance and leadership provided by its Managing Director, Professor Richard Clegg. Richard has promoted the Foundation to the wider LR group and other major stakeholders and has been instrumental in building relationships with universities, beneficiaries, government and others in the charity sector. The respect in which he and the Foundation are now held, is a credit to the hard work which he and his able team have performed during the year.

I should also like to thank Keith Povey who stood down as Secretary of the Foundation in July 2015, having helped to set up the Foundation as a charity, established its governance and structure, and guided the trustees during the early development stages. We are pleased that Michelle Davies has agreed to take over as Secretary and look forward to the contribution she can bring.

Finally the trustees would like to extend their thanks and appreciation to Richard Sadler, CEO of LR, for his strong leadership of the Foundation's trading group during continued difficult economic times. Having advised the Foundation of his desire to step down as CEO later in 2015, the trustees are pleased that Alastair Marsh has agreed to take on that demanding position, and they look forward to working with him in this role in the future.

The relationship between the Foundation and its trading group continues to develop and we see this as bringing new opportunities to increase the benefit we can bring to society. We will continue to use all resources of the group, and work together to help address the risks of living in today's society, and make it a safer and more well-informed world in which to live.

Thomas Thune Andersen

Chairman, Lloyd's Register Foundation



We believe that as the pace of technological change increases, the Foundation will have a unique and important job to fulfil.

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MANAGING DIRECTOR'S REVIEW

Taking the long view



A unique feature of the Foundation is that we're able to focus on the long term, tackling the root problems facing society rather than just alleviating the symptoms.



As you will read in these pages, 2014/15 has been an exciting and impactful year for the Lloyd's Register Foundation. We've been focused on turning our strategy into practice and, in the process, generating benefits for society in line with our charitable aims.

A unique feature of the Foundation is that we are able to focus on the long term because of our governance structure and the assets we own. In many cases we work with our grants community to build long-term relationships, working together on the challenges facing modern society. This means our funding can go into tackling root problems rather than just alleviating the symptoms. It also means that our grants can be significant, both in terms of their value and duration.

We are proud to have committed £9 million of grants for research and education in the field of nanotechnology. This is the culmination of an international review we commissioned last year, and published in April 2014, that assessed the state of the art and impact of nanotechnology in the sectors relevant to our Foundation. Following an international competitive call for proposals, our original intention was to select and fund just one proposal. But the response was of such high quality that we decided to allocate more funding and awarded grants to three international consortia. We are very proud to say that one of these is with Professor Sir Andre Geim, a Nobel Prize winner at The University of Manchester. With all the

groundwork now in place, we look forward to working with all three consortia over the next five years to advance the impact of nanotechnology on enhancing safety in the sectors we serve.

In the spirit of taking the long view, we also commissioned three further foresight reviews, similar to the one in nanotechnology, focused this time on the areas of big data, resilience engineering and structural integrity. We published our big data foresight review in December 2014, and the other two will be published in October 2015. Our big data report focuses on the new subject area we are looking to develop that we are calling 'data-centric engineering'. We are pleased that our early work in the big data field has culminated so far in the award of a major and significant grant to the Alan Turing Institute, being established in the UK. We look forward to reporting on the outcome of this in more detail in the future.

Being responsive

Throughout 2015 we have remained open to good ideas coming from our wider community suggesting projects where the Foundation can make a difference. We see it as important to promote and be responsive to such unsolicited proposals, complementing our more directive approach, such as through the foresight reviews I have already mentioned. In 2015 we are proud to have received 174 responsive mode applications, 32 of which we funded.

To help us manage the volume of applications we receive and the grants we give, we are investing in a grants management database and look forward to more streamlined processes as a result, which will also benefit those applying.

We are developing our social media presence and other ways to disseminate information about how our funding is making an impact. Through our activity on social media we are attracting an exciting new audience, in particular the younger generations, and encouraging future interaction with the Foundation.

Our charitable work is made possible by the success of the Foundation's trading arm, Lloyd's Register Group Ltd (LR), which generates much of our income. The trading activities of LR also contribute to the charitable purpose of the Foundation. It is through this unique combination that the Foundation and LR are able to add value to society, enhancing safety and advancing public education in line with our shared vision.

Professor Richard Clegg
Managing Director of the
Lloyd's Register Foundation

MISSION, VISION, STRATEGY

Our strategy sets out how we will achieve our vision

Our mission

To secure for the benefit of the community high technical standards of design, manufacture, construction, maintenance, operation and performance for the purpose of enhancing the safety of life and property at sea, on land and in the air.

The advancement of public education including within the transportation industries and any other engineering and technological disciplines.

Our vision

Our vision is to be known worldwide as a leading supporter of engineering-related research, training and education that makes a real difference in improving the safety of the critical infrastructure on which modern society relies. In support of this, we promote scientific excellence and act as a catalyst working with others to achieve maximum impact.

Strategic themes:

1 Supporting excellent scientific research



2 Accelerating the application of research



3 Promoting safety and public understanding of risk



4 Promoting advancement of skills and education



Objectives:

- Striving for excellence and impact
- Promoting technology foresight
- Building world-class research teams

- Accelerating technology uptake
- Informing standards and policy
- Facilitating the mobility of researchers

- Promoting the safety of life, property and the environment
- Enhancing public understanding of risk
- Maintaining and promoting a memory bank of safety and risk management developments

- Inspiring the next generation
- Enhancing the knowledge and skills of the workforce
- Widening access to disadvantaged and under-represented communities

Funding priorities:

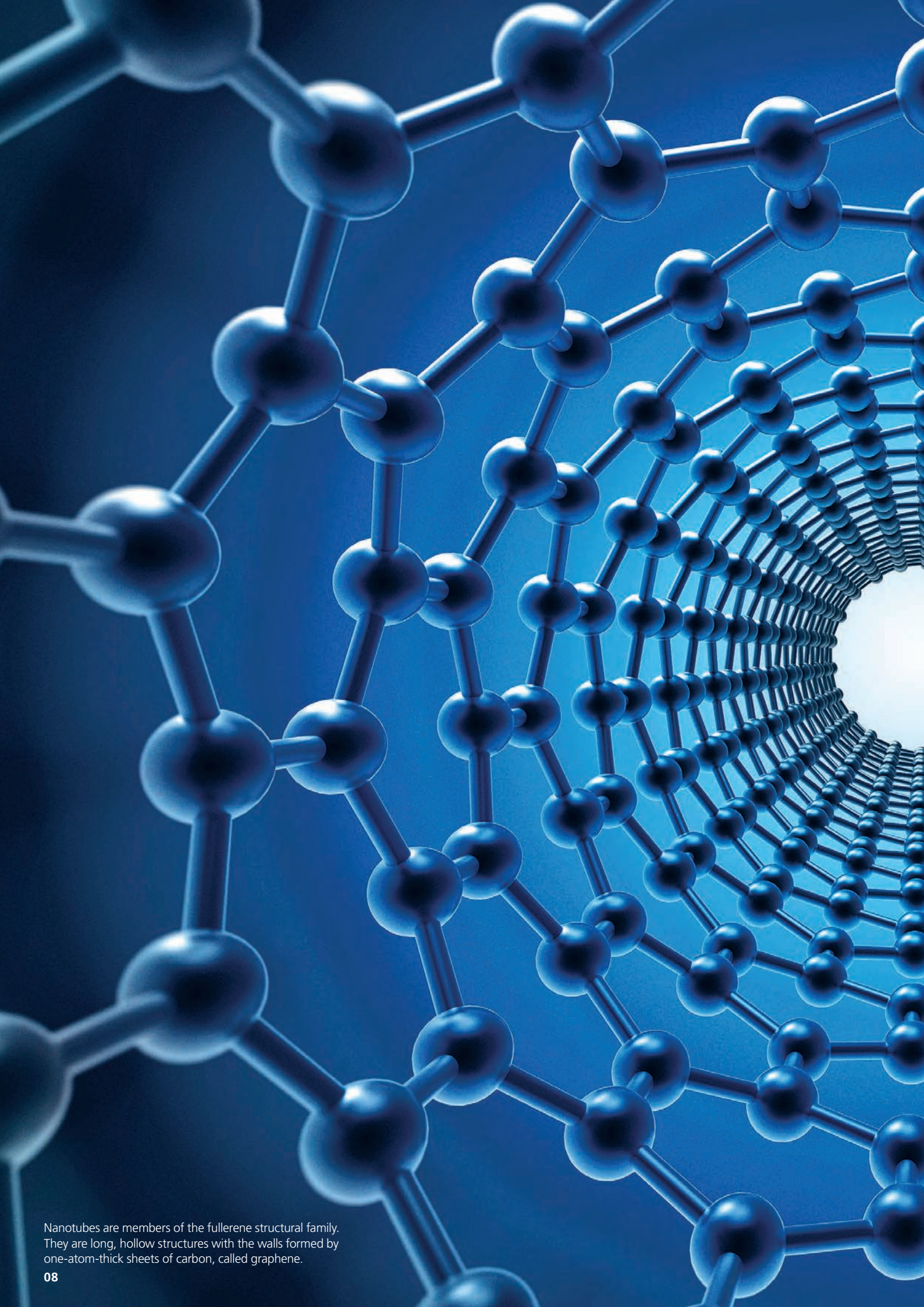
- Structural integrity and systems performance
- Resilience engineering
- Human and social factors
- Emergent technologies

- Supporting safety organisations
- Communication and public debate of scientific research
- Developing the Foundation's Heritage and Education Centre library and archive

- Pre-university education
- University education
- Vocational training and professional development

Sectors we serve:

- Aerospace
- Automotive
- Built environment
- Food
- Healthcare and medical
- IT and communications
- Manufacturing
- Marine
- Oil and gas downstream
- Oil and gas upstream
- Power and utilities
- Rail and metro



Nanotubes are members of the fullerene structural family. They are long, hollow structures with the walls formed by one-atom-thick sheets of carbon, called graphene.



Strategic theme 1

SUPPORTING EXCELLENT SCIENTIFIC RESEARCH

Objectives

- Striving for excellence and impact
- Promoting technology foresight
- Building world-class research teams



A full list of funded programmes can be found on our website www.lrfoundation.org.uk/programmes



We plan to exploit the breakthrough discoveries made by our groups over the last five to 10 years and endeavour into unknown territories, aiming at opening new research fronts and developing fundamentally new technologies. At every step, we will try to align our research efforts with LRF charitable goals.

Prof Sir Andre Geim
University of Manchester

Case study

BRINGING TO LIFE THE FORESIGHT REVIEW OF NANOTECHNOLOGY

Nanotechnology is an emerging technology of major relevance to the engineering-related sectors of importance to the Foundation.

In 2013, we drew together an international expert advisory panel and published the resulting report, Foresight review in nanotechnology: the next industrial revolution, in April 2014. This type of activity supports excellent scientific research as well as accelerating the application of research.

We opened an international call for research proposals in August 2014, looking for proposals that address some of the gaps or 'white space' in nanotechnology research. There was a strong response to the call and in March 2015 the Foundation awarded grants to three international research consortia.

Designer nanomaterials assembled from individual atomic planes

This work aims to create prototype nanomaterials with designed functional properties through the assembly of atomic planes from a variety of bulk crystals. Such materials could have a broad range of safety applications across many industries including flexible optoelectronics, energy harvesting, gas separation and water desalination.

Consortium: led by Nobel laureate, Professor Sir Andre Geim, University of Manchester with the UK's National Graphene Institute, Harvard University, National University of Singapore, ETH Zurich and Japan's National Institute for Materials Science.

Nanotechnology in subsea power infrastructure

This work will explore the potential of copper/carbon nanotube metal matrix composites in the fabrication of electrically conductive materials with enhanced properties for use in subsea power transmission applications.

Consortium: led by Professor Sir Mark Welland, University of Cambridge with the National University of Singapore, Texas A&M University and the UK's Institute of Occupational Medicine.

International doctoral consortium in nanotechnology

This consortium will develop an international cohort of doctoral students to build capability and knowledge in the application of nanotechnologies to support the safety of life and property, addressing the areas highlighted in the foresight review. It will bring together international experts and industrial stakeholders and build on shared capability held in physical infrastructures such as laboratories, test facilities and specialist equipment.

Consortium: led by Dr Themis Prodromakis, University of Southampton, with other members to be added over five years.

STRATEGIC THEME 1

Supporting excellent scientific research

Activities and impact

These are the highlights in progress towards achieving our objectives and furthering our charitable activities.

Programmes around the world

We continued funding 19 programmes across 39 institutions around the world covering a range of subjects including transport safety, ship design and water security. In addition, we have four partnerships with other institutions through the UK's National Structural Integrity Research Centre (NSIRC) initiative (described on the next page), with another three pending.

Strengthened governance

To support us in selecting high-quality research we have set up stronger governance processes for the assessment of grant applications. This includes initiating an international college of external peer reviewers.

Directed approach to research funding

We are increasingly taking a directed approach to research funding, placing or supporting open calls aligned with our strategic funding priorities, for example, the call for proposals in nanotechnology (as described on page 9). To support our transition to a more strategic and directed set of programmes we established a follow-on fund in September 2014. This fund builds on valuable research capability developed through grants made under the Lloyd's Register Educational Trust and allows selected research grant holders nearing the end of their grants to apply for funding to address the Foundation's new strategy. In 2014/15 we approved five requests for follow-on funding.



We are setting out the research challenges where we can make the biggest impact in our research funding priorities.

Promoting technology foresight and independent technical reviews

We are setting out the research challenges where the Foundation can make the biggest impact in our research funding priorities.

Our foresight reviews support excellent scientific research and the acceleration of the application of research. In December 2014 we published a report, Foresight review of big data: towards data-centric engineering. We describe this work in more detail in the section on the theme of accelerating the application of research on page 12.



We supported a workshop to explore the subject of resilience engineering held in April 2015 at the Stevens Institute of Technology in New Jersey. Participants from more than 12 countries over five continents came together to share their perspectives on the emerging field of resilience engineering, and to explore how the Foundation might make a distinctive contribution to the field. Experts came from a wide range of infrastructure sectors including healthcare, transport, food and water, and IT and communications, and brought perspectives from industry, government, city and regional-scale planning, and from academia.

The Foundation also supported two workshops exploring structural integrity and systems performance. These workshops were held in Singapore and London and were attended by experts from industry and academia from a dozen countries.

Using output from these workshops and further consultation, the Foundation will publish two foresight reviews, one on resilience engineering and also one on structural integrity and systems performance.

Working with research-funding bodies and learned societies

We worked in partnership with the UK's Royal Academy of Engineering (RAEng) to identify the first joint Lloyd's Register Foundation – Royal Academy of Engineering research fellow. The prestigious and highly competitive RAEng fellowships are offered to the engineering leaders of tomorrow. Dr Mark Batty of Kent University aims to build more robust networked computer systems using rigorous mathematical methods. Such computer systems play an important role in controlling critical infrastructures.

Supporting research sharing

In September 2014, grant holders from around the world came together at the Foundation's Research Colloquium hosted by the University of Southampton. The Foundation supports diverse research groups across a range of disciplines but our shared goal to enhance the safety of life and property gave participants fresh insights and helped us all understand the impact of our research. Discussion sessions focused on the Foundation's research priorities and strategic themes, with participants providing valuable inputs to our future plans.

£15m

funding to support the new NSIRC

Starting research activities in NSIRC

In June 2014, we announced our agreement with TWI (The Welding Institute) to provide £15 million research funding, becoming a founder sponsor of the Structural Integrity Research Foundation, to help establish the new NSIRC in Cambridge, UK. This year has seen us working closely with TWI on commencing research activities in the NSIRC, involving our first sponsored postgraduate student intake. This is described in more detail in the case study on the next page.

Case study

Building the Structural Integrity Research Foundation

During the first year of the Foundation's sponsorship of the UK's Structural Integrity Research Foundation (SIRF) we have been working together with the other founder sponsors to establish a robust governance system. Together we have started to establish a common understanding of the challenges that will be investigated at the operational part of SIRF called the National Structural Integrity Research Centre (NSIRC).

We have set three preliminary areas of research:

- 1 **New materials and manufacturing methods:** these will result in new material solutions that improve safety and reliability
- 2 **The digital twin:** a digital representation of a system or an asset which can predict its condition based on some assumed or measured operating parameters
- 3 **Inspection and maintenance risk reduction:** removing the need to place humans or systems at risk by developing reliable systems that can indicate when a human intervention is required as opposed to periodic intervention that may not be required.

The NSIRC is responsible for all activities related to defining specific research topics, attracting academic partners, leveraging funding to increase the number of postgraduate students benefiting from the initiative, and finding students.

Highlights of this initiative in the first year include:

- recruitment of eight PhD students from Bangladesh, Bulgaria, France, India, Iran, Mexico, Nigeria and Spain from seven degree-awarding universities
- a 50:50 gender ratio
- recruitment of industrial mentors for each PhD which has started to ensure a route to impact
- first Foundation-funded NSIRC student winning a national award
- an opening conference in June 2015.

In the coming year NSIRC will be issuing an open research call that will use the output of the foresight review being carried out in the funding priority of structural integrity and systems performance.



In October 2014, we welcomed our first PhD student, Laura Vivar, to the Foundation-supported National Structural Integrity Research Centre. In the photograph here are the first four of our funded PhD students (left to right) Galatee Levadoux, Peyman Amirafshari, Jazeel Chukkan and Laura Vivar.

Future plans

In 2015/16 we plan to:

- open research calls in the areas of resilience engineering, and structural integrity and systems performance
- implement a programme addressing data-centric engineering in partnership with the Alan Turing Institute (for more detail on our relationship with the Institute see page 15)
- undertake a review to establish where we can have the biggest impact within our research priority of human and social factors
- initiate more reviews in our emerging technologies research priority area, with possible subjects being robotics, autonomous and self-learning systems, and space and satellite technologies and services
- start planning for our next global Research Colloquium to be held in 2016.



Strategic theme 2

ACCELERATING THE APPLICATION OF RESEARCH

Objectives

- Accelerating technology uptake
- Informing codes, standards and policy
- Facilitating the mobility of researchers



A full list of funded programmes can be found on our website www.lrfoundation.org.uk/programmes



The Lloyd's Register Foundation has shone a spotlight on how big data is increasingly central to the design and management of the engineered world. Their £10 million grant offer to the Alan Turing Institute will build knowledge and skills that will not only make that engineered world a safer one, but will also support growth and public service provision.

Prof Sir Mark Walport
UK's Government Chief Scientific Adviser

Case study

TOWARDS DATA-CENTRIC ENGINEERING

In December 2014, as part of our work under strategic theme 1, we published a foresight review of big data and announced a conditional grant offer of £10 million over five years to support research by the Alan Turing Institute on engineering applications of big data.

The report, Foresight review of big data: towards data-centric engineering, looks forward at how developments in the area of big data might impact the safety and performance of the engineering assets and infrastructure on which modern society relies. It draws on the findings of our international expert advisory panel, led by Professor Sir Nigel Shadbolt, Professor of Artificial Intelligence at the University of Southampton and Chairman of the Open Data Institute.

The report sets out four action areas for the Foundation:

- 1 Technology road-mapping:** collaborating with the research community to forecast technology developments in data-centric engineering
- 2 Design for data:** recognising that embedded sensors, intelligent systems and data management will form part of engineering design requirements
- 3 Codes and standards:** as more data is generated, collected, transmitted, stored and manipulated by engineering systems, there is a need for assurance of the quality, traceability, security and integrity of that data
- 4 Data analytics:** developing algorithms and mathematical models for data analysis, helping make informed decisions to enhance the safety, reliability and performance of assets and infrastructure.

It concludes that within the next five to 10 years we are going to witness step changes in sensor technology, data-driven intelligent systems, computer science and algorithms for data analysis, impacting all aspects of the business lifecycle – from design to manufacturing, maintenance to decommissioning.

The report sets the high-level strategic direction and funding priorities for the Foundation in the field of data-centric engineering. Big data is going to bridge the gap from monitoring 'what is' to predicting 'what if'. The Foundation intends to become a major supporter of international research in the field, partnering with organisations including the UK's Engineering and Physical Sciences Research Council.



Computing power and the data it generates is growing exponentially. The unprecedented growth in data will result from ubiquitous sensors, an 'Internet of Things', that will monitor and measure our machines, our businesses, our environment and us.

STRATEGIC THEME 2

Accelerating the application of research

Activities and impact

This year we made excellent progress under this theme towards achieving our objectives and furthering our charitable activities.

Increased focus on impact

We are increasing our focus on the impact of our grant giving. In the past year we have done this by:

- ensuring 'potential for impact' is a key criteria in all our grant giving, both research and education grants
- encouraging applicants to work with end-users especially at the research programmes design stage (co-design)
- opening a call to all current and past grant holders inviting them to consider how their research findings could be accelerated to impact and to apply to the Foundation for support
- implementing our intellectual property policy including its incorporation into our standard grant agreements
- updating our guidance on measuring impact and benefit and on reporting.

Applications to the Foundation must clearly demonstrate expected impacts and benefits. We also require our grant recipients to report to us on the impact and benefits of the activities supported by the grant. Outcome-focused case studies demonstrating specific benefits to society and impact will be the main vehicle for reporting impacts and benefits to the Foundation.



Foresight reviews support two strategic themes

Our foresight reviews help us to achieve excellent scientific research and the acceleration of the application of research. Our work to fund research activity aligned to the outcomes of the first foresight review, on nanotechnology, is described on page 9. In December 2014 we published a report, Foresight review of big data: towards data-centric engineering, described on page 12.



Highlights from research centres

Five of our research centres nearing the end of their grants have reported to us on their impact over the past five years. Highlights from these are given in the following paragraphs.

From 2010 to 2014, the Transport Risk Management Centre at Imperial College published 32 peer-reviewed journal papers, supported seven PhD, 25 MSc and 11 undergraduate research dissertations, generated £1 million additional income and led to safer operations by London Underground, UK Civil Aviation Authority, and air traffic control in the Netherlands and Switzerland.

The University of Southampton's University Technology Centre published 71 peer-reviewed journal papers and secured leveraged funding of more than £7 million from other funders.

The University of Nottingham Centre for Risk and Reliability Engineering has built on the Foundation's initial £698,000 grant, generating over £3 million in additional research funding. Between 2010 and 2015 it produced 86 publications and the research has been applied to systems operated by Network Rail, BAE Systems, Intelligent Energy and London Underground.

The Joint (UK-China) LRF Centre for Deep Water Challenges brings together University College London, Shanghai Jiaotong University and Harbin Engineering University. The Centre has built a world-class research team, currently comprising more than 10 professors and 25 PhD students publishing over 50 papers in high-quality international journals. The Centre's research uptake includes new methodologies and incorporation into software packages for industry. These have been disseminated through Foundation workshops and lectures, interactions with senior managers and engineers at shipyards, offshore oil and gas companies, research institutes and classification societies such as CCS (China Classification Society) and Lloyd's Register. The Centre has built on the Foundation's funding, securing funding from the Chinese Ministry of Industry and Information, National Natural Science Foundation of China and the Chinese Ministry of Science and Technology. A total of over ¥36 million has been granted (approximately £4 million).

Funding at the University of Western Australia has produced a large-scale model for testing oil and gas pipelines to improve stability, yielding a cost to benefit ratio of 10:1.

Inspiring the next generation

Two funded programmes have developed activities that complement another of our strategic themes, promoting the advancement of skills and education:

- the consortium led by City University London has secured three EU Marie Curie Innovative Training Networks providing early career training worth over €12 million. These have built on a grant from the Foundation to develop a programme on cavitation.
- Monash South Africa, in support of the Department of Water and Sanitation, successfully co-organised the 2014 National Youth Summit in Johannesburg, South Africa in July 2014. The Summit brought together over 1,000 learners and educators from different parts of the country to celebrate the involvement of young people in water conservation and management. Monash's participation was made possible through funding from the International Water Security Network (IWSN). The IWSN is funded by the Foundation.

Case study

Towards data-centric engineering: supporting the Alan Turing Institute

In support of our objectives, to become a major sponsor of international research in the field, in July 2015 the Foundation offered a grant of £10 million over five years to the Alan Turing Institute for the purpose of supporting its research in the engineering applications of big data. Its outputs and benefits will be aimed at enhancing the safety, reliability and performance of the major infrastructure on which modern society relies, in line with the Foundation's charitable aims.

The Alan Turing Institute, named in honour of the wartime code-breaker, will be headquartered at The British Library in London. The Institute will provide a national centre to promote advanced research and translational work in the application of data science.

As a global charity, we regard international collaboration and engagement as critical. The Foundation recognises the Institute will fulfil a role at the centre of an international network, collaborating with other world-leading centres.



Potential for impact is now a key criteria in all our grant giving, both research and education grants.

£15m

additional funding from other sponsors generated by four of our funded research centres

New call for proposals

In January 2015, we opened a new call for proposals to accelerate the application of research. We want to maximise the uptake and application of the fundamental research we are engaged in, enhancing safety benefits and focusing on the most promising opportunities for the wider benefit of society. If a suitable opportunity arises to benefit from the commercialisation of intellectual property then, on a case-by-case basis, we may pursue this if the proceeds enable us to subsequently fund further research for greater public benefit. While future grants will increasingly integrate funding for accelerating the application of research, the call recognised that useful results generated by past and current grants may be languishing with no clear route to exploitation.

We invited applications from our researchers addressing our goal to accelerate uptake of previously funded Foundation research. Example grant actions might include:

- ideas for new technologies or improvements to existing technologies that have come out of previously funded Foundation research, with a specific, tangible application or benefit in mind; this may involve, for example, ideas for proof of concept or demonstration studies to advance such ideas to higher-technology readiness levels
- publicising or sharing research findings in innovative ways (for example, beyond academic publishing and conferences)
- input to or building partnerships with policy- and standards-setting organisations leading to improved national or international safety-related policies and standards
- facilitating staff interchange between research and end-user organisations with targeted outputs and benefits in mind.

Future plans

In 2015/16 we plan to:

- carry out periodic external evaluation of the impact of our whole portfolio
- embed the Foundation's innovation model into working practice by the assessment of the first applications under our call for accelerating the uptake of the Foundation's previously funded research
- consider how best to develop and deliver research networks focused on major infrastructure sectors
- support new grant holders who build new partnerships with end-users enabling co-design at the earliest stages of their research.



Our pilot project's investigation into what is required to conserve and digitise the collection, with a view to placing it online and future-proofing it, is highlighting some real gems.



Strategic theme 3

PROMOTING SAFETY AND PUBLIC UNDERSTANDING OF RISK

Objectives

- Promoting the safety of life, property and the environment
- Enhancing public understanding of risk
- Maintaining and promoting a memory bank of safety and risk management developments



A full list of funded programmes can be found on our website www.lrfoundation.org.uk/programmes



The project is a great way to showcase the breadth of our resources. Feedback has indicated its enormous interest to many diverse groups including academics who study linguistics, maritime historians and genealogists – and we want to create a resource for all.

Barbara Jones
Heritage and Education Centre Manager

Case study

DIGITISATION PROJECT: SHARING A UNIQUE COLLECTION ONLINE

October 2014 saw the beginning of the Foundation's Heritage and Education Centre (HEC) pilot digitisation project of a small part of our extensive archives, to put it to work for educational purposes.

This unique heritage collection, currently on loan to the National Maritime Museum, covers Lloyd's Register-classed vessels dating c1834 to c1968. It consists of an estimated 1 million ship survey-related documents, including correspondence, survey reports and ship plans.

This collection has great potential for scholarly insight and individual research as well as future 'big data' sharing on a global scale. People will be able to study the progress of shipbuilding and engineering technology in a unique way by looking at the individual ships and their classification survey reports and plans.

The scoping shows much of this irreplaceable material is in urgent need of conservation where the paper is of poor quality, often acidic, and needs stabilising to prevent it from deteriorating any further. A minor part of the collection is already beyond repair.

Since the start of 2015 we have been meeting with other heritage institutions, such as The British Library, Wellcome Library and SS Great Britain Trust, to discuss experiences and apply this collective knowledge to our own project. International standards and guides have been thoroughly researched to produce our own procedures. Our multiphase plan involves conserving, cataloguing, imaging, preserving and disseminating the collection.

To ensure focus on the needs of the end-user, a survey of different user groups was launched in March 2015; by May this had almost 300 respondents. The project's blog saw over 1,600 hits up to May 2015 covering 38 countries. The interest from the public, academics and professionals has been extremely encouraging and much wider ranging than we anticipated.

Our pilot project's investigation into what is required to conserve and digitise the collection, with a view to placing it online and future-proofing it, is highlighting some real gems. It demonstrates the project's potential, reinforcing the need to ensure that this internationally important collection is preserved and the material made accessible for public benefit and for future generations.

STRATEGIC THEME 3

Promoting safety and public understanding of risk

Activities and impact

A review of progress under this strategic theme in 2014/15.

A large part of this year's work of the Foundation has been surrounding the two strategic themes of supporting excellent scientific research and accelerating the application of research. Even so we have made progress towards achieving our plans under this third strategic theme.

Research and outreach by HEC

In April 2015, our Heritage and Education Centre (HEC) team completed a book, *Maritime science and technology: changing our world*. Based on extensive research, the book tracks the development of marine science and technology and the role that LR has played in this over the last 255 years. Published to commemorate the launch of LR's new Global Technology Centre in Southampton, the 334-page book will be widely distributed within the academic sphere, encouraging and supporting current and future research and enhancing public understanding in these areas.

This year the HEC successfully completed the upgrade of the online library catalogue to improve global accessibility to our collections.

The team has answered over 13,000 enquiries from business, students, academia, institutions and members of the general public and has supported authors and shipping company anniversaries, helping to widen maritime engineering and scientific knowledge.

Visits from universities and other bodies, organised and hosted by HEC for training lectures, resulted in more than 1,100 academics, students and visitors being introduced to the work of the Foundation and LR. The year saw a rise in the number of visits from special interest groups including the Port of London study group and International Maritime Organization interns.

Our dedicated @LR_InfoCentre Twitter page has helped us to raise the public's awareness and interest in the digitisation project. In one month we produced 125 tweets generating 40,300 impressions, an increase of 37.2% over the previous month.

HEC interns

The HEC has recruited two interns to help with the digitisation project. Their ongoing work includes the pilot digitisation project of a portion of LR ship plans and survey reports. They have also been examining potential conservation of documents, cataloguing and imaging methods, before the digitised content can be uploaded for public use, and assisting the general work of the HEC.

“The level of responsibility I've been given has been much higher than I originally anticipated, which has allowed me to develop my skills extensively and learn some new ones.

Charlotte Atkinson, Intern



Interns Sean Clemenson and Charlotte Atkinson.

“I have found the experience to be incredibly influential and look forward to continue playing an active role in this exciting project.

Sean Clemenson, Intern

HEC library and archive

As the custodian of the Foundation's library and archive, the HEC is committed to maintaining and promoting this unique resource and making it freely available for education and research purposes worldwide. The collection in London contains over 80,000 items of current and historical information concerning maritime history, engineering science, naval architecture, offshore engineering and ocean technology, available to all researchers. In addition, HEC continues to capture details of the current activities of LR and the Foundation to keep this a dynamic and contemporary collection for the future. Its aim is to enhance public understanding in these areas, encourage and support current research and to assist with research concerning the history and development of the group globally.

800

people downloaded the Foundation's first two foresight reviews

Sharing knowledge

The foresight reviews of nanotechnology and big data were both made freely available on the Foundation's website to provide insights for the research community and also inform a wider debate in society about the engineering safety-related challenges being investigated by the Foundation. During the year the nanotechnology review was downloaded by 444 people and the big data review by 356 people. Readers included academics, industry professionals and interested individuals from 50 countries.

As well as publishing some 315 academic papers, books and chapters during the year, our research partners took part in conferences, workshops and seminars and their findings are published in conference proceedings.

Public events held by our funded programmes during the year included a symposium on scenario-based risk management of Arctic shipping and a lecture entitled Unlocking energy resources offshore: engineering challenges from renewables to deepwater.

The work of Lloyd's Register

Our trading arm, LR, is a key contributor to the achievement of the first of our objectives: promoting the safety of life and property. LR is a global engineering, technical and business services organisation, providing independent assurance and expert advice to help ensure that its clients' assets and processes are safe, responsible and sustainable. A few of LR's highlights in the year related to this objective include:

- New guidance notes on offshore collision. Mitigating the risk of collision at sea requires a deep understanding of the causes. LR's new industry guidance helps to make offshore operations safer.
- The design of all-weather lifeboats is being reviewed as part of a study led by Newcastle University and the UK's Royal National Lifeboat Institution (RNLI) with support from LR.
- LR has found a novel way to help shipowners and operators lower their carbon footprint and meet the recently introduced 0.1% sulphur limits in emission control areas, using a series of computational fluid dynamics studies and calculations.
- LR's new Container Certification Scheme 2015 gives a clear and concise set of rules to ensure offshore and onshore containers are safe and certified correctly.



- To maximise safety in offshore operations, structures and equipment that could be subjected to blast pressures, need to be designed for accidental blast loading. LR's new guidance notes provide recommended practices to help engineers, operators and designers to define blast and explosion loads to control and mitigate risk measures.

1m

LR class helps ensure safety of some 1 million cruise passengers each year



Future plans

In 2015/16 we will aim to develop our activities in this strategic theme and plan to:

- deliver the next stage of the HEC's pilot digitisation project of historic ship plans including running a trial digitisation of selected famous or interesting ships which we are identifying in the initial scoping process
- develop the HEC's social media presence to forge stronger relations with the general public, academics and professionals in relevant sectors
- hold a conference that will bring together some of the most forward-thinking, innovative minds in the industry to discuss the digitised archive of the future
- undertake a review of the issues and barriers connected with the communication and public understanding of matters relating to risk in order to identify the 'white space' areas where the Foundation can make a distinctive contribution in this area
- continue to work with our trading arm, LR, to help deliver our charitable aims.



Strategic theme 4

PROMOTING ADVANCEMENT OF SKILLS AND EDUCATION

Objectives

- Inspiring the next generation of engineers
- Enhancing the skills and knowledge of the workforce
- Widening access to disadvantaged and under represented communities



A full list of funded programmes can be found on our website www.lrfoundation.org.uk/programmes



The work will identify key strategic areas where intervention can make a real difference in opening opportunities in engineering to young people.

Philip Greenish
Chief Executive, Royal Academy of Engineering

Case study

ADDRESSING THE SKILLS SHORTAGE IN THE UK

The Foundation's scope is global, with a focus on the UK where we can achieve greatest impact. To meet our objective of inspiring the next generation we are particularly addressing the UK's critical skills shortage in engineering.

Analysis by the Royal Academy of Engineering (RAEng) suggests that by 2020 there will be a demand for 1.28 million workers in science, engineering and technology roles, with over 1 million of those needed in engineering at graduate and technician level. The supply of young people with relevant qualifications is too low to meet this demand.

To increase supply, organisations have been undertaking a wide range of initiatives and activities to encourage young people to pursue science, technology, engineering and mathematics (STEM) subjects to post-16 education or degree level. Initiatives by charities, industry, volunteers, professional societies, universities and others, include curriculum enrichment, teachers' professional development, careers resources, after-school clubs and teaching resources. This makes the STEM landscape crowded, complex and incredibly difficult to navigate. There is also the question of impact as many activities are not evaluated.

Funding from the Foundation has supported a project by the RAEng to undertake a mapping of the UK STEM landscape and gap analysis, aiming to achieve a better understanding of the sector and supporting the wider STEM community. This project is described in more detail on page 22.

The main output will be a published report (which will be available on our website) identifying where the gaps are in the provision of STEM activities and resources. It will recommend where funding could be best targeted to make a significant impact in improving young people's uptake of STEM subjects and routes into engineering. This will inform our own decision-making and be of value to other funders, industry and delivery organisations.

The RAEng held two consultation events to share the findings in February and April. After some initial scepticism about how the process would work, its purpose and legacy, the overwhelming view of the sector is welcoming and supportive.

We will review the report in 2015/16 to decide where to prioritise our grant spend to ensure we achieve maximum impact in meeting our objective of inspiring the next generation.



Encouraging young people to pursue science, technology, engineering and mathematics (STEM) subjects is key to meet the forecast shortage of tomorrow's engineers.

STRATEGIC THEME 4

Promoting advancement of skills and education

Activities and impact

A review of progress under this strategic theme in 2014/15.

Review of portfolio

Many of the programmes we support within this strategic theme are grants made by the Lloyd's Register Educational Trust and transferred to the Foundation in 2013. To ensure that we achieve maximum benefit from our grants funding, we have taken time this year to review our portfolio, our direction and where we should target our interventions to achieve maximum impact and public benefit. During this period of transition we have not made any major grants. However, we are pleased to report some significant successes aligned with our strategy, some associated with relatively small grants.

Highlights from funded schemes

- The St Paul's Way Trust Science Summer School, an innovative annual programme of TED-style seminars, discussions and hands-on experiments, is designed to inspire the next generation of scientists and engineers. Hosted by Professor Brian Cox OBE, the programme involves children from over 30 schools in disadvantaged London boroughs, alongside some of Britain's most successful scientists. Our grant of £45,000 over three years supports delivery and growth, doubling the number of partner schools and increasing the number of participants to 600.
- Our first year of funding the Worshipful Company of Shipwrights has enabled five new apprenticeships at four companies, with 15 applications pending and more expected from July 2015 onwards, in a range of marine engineering and supply chain industries. This helps us meet our objective of enhancing the knowledge and skills of the workforce. Companies new to apprenticeships are eligible to receive a grant for first-year wages. They can then apply for a loan to take on more apprentices. Small businesses find this an incentive while using loans makes the scheme sustainable. With the support

of the British Marine Federation, Society of Maritime Industries and others, the scheme's administrator is engaging industry. When Fairline, a production motor and super yacht manufacturer, wished to re-establish apprenticeship training, the administrator set up links with the local college in Corby. As a result, a new boat-building course started in September 2015, training up to 25 apprentices. These successes show the long-term impact of our grant.



Small grant successes

We awarded six small grants in 2014/15, categorised as grants under £20,000. The activity for most of these will take place in 2015/16; three schemes had success this year.

- We supported the Smallpeice Trust's Girls into Engineering residential course for 100 girls aged 12–14, providing 50% match funding. Almost half of participants were from state schools. Feedback was positive and we agreed to fund the course in July 2015.
- Fun Kids Radio created a second series of marine-related audio and web content about Sean's Ultimate Ship, on sustainability and safety, aiming to reach over 170,000 children and parents.
- Winchester Science Foundation used our small grant of £5,000 awarded in 2013/14 to widen access to Winchester Science Festival. Four hundred free tickets were distributed, giving many families and young people, in circumstances which would normally preclude them from such visits, the opportunity to engage with science and engineering. This year we agreed a grant of £15,000 over three years. Our funding should leverage support from other sources to make this initiative sustainable.

Case study

Addressing the skills shortage in the UK: the mapping and gap analysis

The RAEng took a collaborative approach to carry out the mapping and gap analysis to benefit from shared knowledge and help create future involvement across relevant sectors.

In January 2015, the RAEng shared the concept and project plan with key stakeholders, including EngineeringUK, STEMNET, British Science Association, National Science Learning Centre, and the UK's Department for Business, Innovation & Skills. All agreed that this was an ambitious task and considered that shared knowledge should result in over 80–90% of activity being captured. A database was created and populated from a range of pre-existing sources, detailed desk research and consultation, and this now contains over 600 entries. The report will be based on an analysis of the data, combined with a review of relevant published research.

The RAEng is discussing with potential partners the future of the database, noting that there is an appetite within the sector for maintaining it as a helpful national resource for knowledge sharing, which may lead to increased collaboration.



The work the Royal Academy of Engineering is doing with the Lloyd's Register Foundation on mapping the UK STEM education landscape is important groundwork. It will identify key strategic areas where intervention can make a real difference in opening opportunities in engineering to young people. Such a picture has not been available before and it will be useful for other stakeholders to build on.

Philip Greenish
Chief Executive, Royal Academy of Engineering

Skills and education new grants 2014/15

- Tomorrow's Engineers' Risky Business stage show at the Big Bang, £40,000. This aims to show to young people that risk is a 'can do' thing. This also fits with the Foundation's strategic theme of promoting safety and public understanding of risk.
- St Paul's Way Trust, Summer School, £45,000.
- Smallpeice Trust, Girls into Engineering, £20,000.
- RAEng, mapping and reporting on the UK STEM landscape, £20,000.
- RAEng, Higher Education Partnerships Newton Fund workshop in South Africa June 2015, £15,000.
- Children's Radio UK, £9,500.
- Institute of Materials, Minerals and Mining, £7,500.
- Winchester Science Foundation, £15,000.



We have taken time this year to review our activity under this theme to ensure that we achieve maximum benefit from our grant funding.

Future plans

In 2015/16 we will aim to develop our activities in the strategic theme and plan to:

- review the report published by the RAEng of the UK STEM landscape; we aim to spend 10% of our total annual grants on skills and education, with 20% of this addressing the engineering skills gap in the UK
- fund one further programme related to apprenticeships in the UK in 2015/16, having tested and learned from one apprenticeship programme in 2014/15
- tackle our objective of widening access in several ways. In the UK, we will focus on increasing the number of women who are under-represented in STEM subjects and careers, particularly engineering, and on disadvantaged communities where our support can open up STEM opportunities
- internationally, we will work with partners to identify where interventions to improve teaching of technological disciplines can improve safety, particularly in countries acquiring high-hazard technologies. A small grant awarded to the RAEng to fund a workshop in Pretoria, South Africa, will help us decide on an implementation plan
- while we move towards a more directive approach to grant funding, we continue to be open to unsolicited applications. To ensure that the limited grants spend makes the greatest impact in achieving our objectives, we will explore the best way to allocate funds. To help our applicants, we will improve guidance on our website, and publish deadlines for applications.

GOVERNANCE AND MANAGEMENT



The Foundation is governed by a Board of Trustees, which is responsible for setting the Foundation's strategy, for ensuring good governance and that it fulfils its objectives – delivering public benefit.

1 Thomas Thune Andersen

Thomas is the Chairman of the Lloyd's Register Foundation and Chairman of Lloyd's Register Group Ltd. Thomas, a former member of the board for the A.P. Moller-Maersk Group with almost 32 years in the maritime and energy sectors, was appointed to the board of the former Lloyd's Register in June 2010. Thomas is Chairman of Dong Energy A/S, Chairman of DeepOcean Group Holdings BV, a board director of Petrofac and a board director of VKR Holdings, the parent group of Velux.

2 Sir Brian Bender

Brian retired from the Civil Service in 2009, having been a Permanent Secretary for nearly 10 years. His final position was at the Department for Business, having served previously at Defra. He is Chairman of the London Metal Exchange, Chair of Water UK, a governor of Dulwich College and non-executive director of the Financial Reporting Council, among other posts.

3 Ron Henderson

Ron is a chartered accountant and former CFO of Network Rail and Balfour Beatty. In addition to other non-executive roles, he also served on the UK Auditing Practices Board. He chairs the Audit, Risk and Investment Committee.

4 Rosemary Martin

Rosemary is Group General Counsel and Company Secretary of Vodafone Group. She was previously CEO of the Practical Law Group and spent 11 years with Reuters Group Plc in various company secretary and legal roles. Before joining Reuters, she was a partner with Mayer, Brown, Rowe & Maw. Rosemary was admitted as a solicitor in 1984 and holds a degree in philosophy and literature and an MBA in legal practice. She is a non-executive director of HSBC Bank Plc (the European arm of HSBC Group) and a member of the Financial Services Authority's Listing Group Advisory Committee.

5 Carol Sergeant

Carol has non-executive positions on the boards of Danske Bank, Tullett Prebon plc and Secure Trust Bank. She is also Chairman of the whistle blowing charity Public Concern at Work and Chairman of the BSI Standards Strategy and Policy Committee. She has previously been Managing Director on the board of the FSA, and Chief Risk Officer at Lloyds Banking Group, having begun her career at the Bank of England.

6 Lambros Varnavides

Lambros is the former Managing Director and Global Head of Shipping at The Royal Bank of Scotland. He is Deputy Chair of the Baltic Exchange and sits on its Finance and Charity Committee. He is also a court assistant to the Worshipful Company of Shipwrights and sits on its Finance Committee. He chairs the Grants Committee.

The Board is currently made up of six trustees who are also the members and directors of the Foundation for Companies Act purposes. The Board considers Foundation policies, receives committee reports and recommendations, approves annual budgets, reviews the performance of the trading arm, and guides the Managing Director.

The Board is supported by three subcommittees, which have delegated authority on certain matters (grants; audit, risk and investment; and nominations). Trustees and other non-executives sit on these subcommittees.

The Managing Director, Richard Clegg, is responsible to the Board for the operation of the Foundation.

For the future, there are likely to be factors inside and outside the Foundation's control that are relevant to achieving our objectives. In the case of the management of risks, these are monitored by the Board of Trustees and the Audit, Risk and Investment Sub-Committee. Risks are identified and assessed and controls are reviewed throughout the year. We have worked hard to build up an appropriate governance structure that is consistent with our charitable vision. Under this structure, there is a clear separation between the Foundation's charitable activities and the profit-making activities of LR.



Organisational structure

The Foundation has a total of 12 dedicated staff. A service level agreement exists between the Foundation and its trading group, LR, for the provision of specialist business support in areas including finance, HR, communications, legal services and IT. The Foundation pays for these services at an agreed market rate.

Grant making policy

All grant applications over £20,000 which pass the first review stage are considered by the Grants Committee. Major research grant applications are subject to peer review. Independent expert advice is also sought on defining the scope of research areas where the Foundation is planning to award grants. Final decisions on these applications are made by the trustees. The Managing Director has delegated authority from the Board to approve small grants up to £20,000 and to incur expenditure agreed by the Board.

Details of available funding and the application process are published on our website. Grant holders are required to submit staged reports as part of the process to track delivery against the agreed grant objectives, as well as to monitor the impact and public benefit being generated.

Lloyd's Register Foundation leadership team

Melanie Collins

Grants Administrator

Barbara Jones

Heritage and Education Centre Manager

Dr Jan Przydatek

Programme Leader for Structural Integrity and Systems Performance

Professor Richard Clegg

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