

Science Budget and Industrial Strategy

House of Commons Science and Technology Committee

Submission from the Royal Academy of Engineering

October 2017



About the Royal Academy of Engineering

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.

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Introduction

1. The Royal Academy of Engineering welcomes the opportunity to submit evidence to the House of Commons Science and Technology Committee's *Science Budget and Industrial Strategy* inquiry. The Academy's submission has been informed by the expertise of its Fellowship, which represents the nation's best practising engineers, including leading researchers, industrialists, innovators and entrepreneurs.
2. The Academy welcomes the government's commitment to increasing R&D spending to 2.4% of GDP within the next 10 years, with a long-term goal of 3%. The Academy has previously called for government to commit to such a target.¹ The additional £4.7 billion investment in R&D committed by the government in the Autumn Statement 2016 provides a significant and very welcome uplift to the UK's R&D investment. However, the government's 2.4% target cannot be achieved by public investment alone. While a substantial body of evidence has shown that public investment in R&D crowds in private investment,² it is important that government works with the private sector to design a roadmap to set out how to achieve the 2.4% and 3% goals.
3. In response to the government's industrial strategy Green Paper consultation the Academy led the 38 professional engineering organisations represented in the Engineering the Future alliance to provide a collective response. The resulting report, *Engineering an economy that works for all*, benefited from an unprecedented level of engagement by the engineering community.³ The report distils evidence and opinion gathered through a series of 10 workshops across the UK and a survey of the profession that received nearly 1,300 responses. The report identifies seven overarching actions necessary for a successful industrial strategy: clearly define an ambitious, bold, global vision; provide long-term commitment and stability; adopt a systems approach; build on what already exists; support culture change through communication and engagement; embed actions to promote inclusion and societal benefit; and, prepare for a digital future. This submission draws on our response to the industrial strategy Green Paper.⁴
4. The Royal Academy of Engineering, along with its sister Academies, the Academy of Medical Sciences, the British Academy and the Royal Society, are working together to generate new evidence to ensure that future decisions on investment in research and innovation are informed by the best available analysis. With this project we aim to develop a better understanding of the ways in which research and innovation in the UK generates social and economic benefits, and the distribution of those benefits. The analysis will be commissioned in winter 2017 by an expert Steering Group, chaired by Lord David Willetts.

¹ [Engineering an economy that works for all](#), industrial strategy Green Paper response, Royal Academy of Engineering and Engineering the Future, April 2017 and [Open for Business](#), National Academies, 2016

² [What is the relationship between public and private investment in science, research and innovation?](#) Economic Insight, BIS, 2015; [The Economic Significance of the UK Science Base](#), Haskel et al, 2014

³ [Engineering an economy that works for all](#), industrial strategy Green Paper response, Royal Academy of Engineering and Engineering the Future, April 2017

⁴ [Engineering an economy that works for all](#), industrial strategy Green Paper response, Royal Academy of Engineering and Engineering the Future, April 2017

Context

5. The UK's research and innovation system is undergoing a period of unprecedented change. These changes apply across all facets of the system and occur against the backdrop of the UK's departure from the EU, which could also have a significant impact on the UK's research and innovation system. Key changes include: the creation of UK Research and Innovation (UKRI); the enshrining of the Haldane and balanced funding principles into legislation; the introduction of the Newton Fund and Global Challenges Research Fund; the development of an industrial strategy; the creation of the Industrial Strategy Challenge Fund (ISCF); and the establishment of the Rutherford, Research Talent and Connecting Capability Funds. A number of reviews addressing wider elements of the UK's research and innovation system are also underway, including HM Treasury's Patient Capital Review,⁵ the Review of the Small Business Research Initiative (SBRI)⁶ and independent research into different institutions' principles and practices on commercialisation of intellectual property.⁷ In addition, an International Research and Innovation Strategy is under development and UKRI will also be producing a strategy once it is in operation.
6. The government's recognition of the role research and innovation can play in securing the UK's economic and social prosperity is welcome, as is the significant investment government is making to achieve its ambition of being the best place in the world for research and innovation. Once the industrial strategy white paper has been published, and in view of the significant changes to the UK's research and innovation system, it will be important for government to produce communication materials that enable the research and innovation community, including business and industry, to understand the new structures and funding mechanisms in the research and innovation system. To build stakeholders' confidence, such information should also endeavour to provide clarity on the government's vision for the future of UK research and innovation.
7. Given the substantial changes occurring in the research and innovation system, one of the overarching recommendations from our industrial strategy Green Paper response to adopt a systems approach is especially important.⁸ A systems approach will enable risks to be mitigated more effectively and ensure that the different incentives, policies and initiatives work together as a coherent whole. A key element of this approach is understanding dependencies between different parts of the system, in order to identify both fragilities and opportunities to aggregate value and reinforce outcomes. A clear strategic framework will also be needed within which all key stakeholders, including multiple government departments and key actors at national, regional and local levels can collaborate and cooperate and so are mutually reinforcing rather than competing or unnecessarily duplicating.

The coherence and links between the Industrial Strategy Challenge Fund and the 'sector deals'

8. The Academy believes that prioritisation is an essential component of any strategy and both the 'sector deals' and ISCF provide an opportunity for the public and private sectors to work together to ensure that best value is delivered from their collective resources.

⁵ [Royal Academy of Engineering's submission to HM Treasury's Financing growth in innovative firms consultation](#), 2017

⁶ [Royal Academy of Engineering's submission to the BEIS Review of the Small Business Research Initiative](#), 2017

⁷ [Building our Industrial Strategy: green paper](#), HM Government, 2017

⁸ [Engineering an economy that works for all](#), industrial strategy Green Paper response, Royal Academy of Engineering and Engineering the Future, April 2017

9. It is premature to assess the coherence and links between the ISCF and 'sector deals' as neither the industrial strategy white paper nor the 'sector deals' have been published. For a number of sectors, the government asked for independent reviews as an initial step. The first four of these have now been published.⁹ These are important for providing an evidence base for government to decide which sectors to support and how best to support them in partnership with other stakeholders. Links can be observed between the published reviews and the first wave of ISCF challenges, for example, between Sir Johns Bell's Life Science Industrial Strategy report and the £197 million committed from the ISCF for Leading Edge Healthcare.¹⁰ However, it is not yet clear from these published reviews how coherence and links between 'sector deals' with the ISCF will be achieved. Nevertheless, it is clearly important that there is coherence. Alignment and complementarity, where appropriate, may increase the impact of both initiatives.
10. To maximise the opportunity presented by 'sector deals', government should require a shared commitment by industrial and business organisations within the sector to boost investment in R&D and associated manufacturing capability, matched by government co-investment. Conditions should be optimised to facilitate SMEs participation in research and innovation to support their growth and the strength of key UK supply chains. 'Sector deals' should also encompass actions targeted at strengthening access to skilled people and international markets. The needs and maturity of sectors vary considerably and 'sector deals' must be available to communities focused on enabling technologies and capabilities, such as manufacturing; and smaller or emerging sectors, especially those with large numbers of startups and without corporate champions. It is important the UK also looks ahead to the technologies and sectors of the future. There is a perception that industry silos will decrease over time as more enabling technologies and capabilities that underpin numerous sectors emerge. It is essential that the 'sector deals' do not operate in silos. Once the industrial strategy white paper is published it is anticipated that greater clarity will be provided on the operation, scale and resourcing of 'sector deals'.
11. The development of the ISCF is further advanced. The first wave of challenges to be funded by the ISCF was announced earlier this year. While the agility of government is to be commended in setting up the ISCF, speed should not be at the cost of a clear, strategic and ideally transparent decision making process. As further waves of challenges are developed the selection process employed should be designed to ensure that the full potential of the ISCF is achieved.¹¹ A timeline and funding trajectory for the ISCF would be welcomed. While it is known that the ISCF will be derived from the £4.7 billion uplift investment in R&D uplift, clarity on the size of the total allocation would be welcomed.

The model adopted by the Faraday Challenge and its suitability for future investments in other sectors under the Industrial Strategy Challenge Fund

12. The current and proposed ISCF challenges vary enormously in scope, scale and requirements. Therefore, the models adopted for each of the challenges will require different approaches, tailored to address the barriers and opportunities specific to each challenge. However, there are some common ambitions that should be shared by all challenges areas. These include substantially boosting the innovation and productivity performance of UK SMEs and increasing the number of companies who export. In addition,

⁹ [Life Sciences: Industrial Strategy](#), 2017; [Independent Review of the Creative Industries](#), 2017; [Growing the artificial intelligence industry in the UK](#), 2017; and [Made Smarter Review](#), 2017

¹⁰ [Life Sciences: Industrial Strategy](#), 2017 and

¹¹ [Advice on the ISCF: Council for Science and Technology Letter](#), 2017

it will be essential that the approach taken by the ISCF provides opportunities for wider conditions of success to be addressed for each challenge area such as skills, infrastructure, regulations and standards.

13. Evidence shows that innovation agencies that target higher risk innovations benefit from autonomy and the ability to respond with agility and flexibility, with the US DARPA and IARPA programmes cited as exemplars.¹² The ISCF approach of appointing Challenge Directors, supported by a group of advisors, is intended to be similar to the DARPA model.¹³ It is essential that the ISCF operates with significant autonomy and is run by staff with relevant expertise.
14. Innovation is an inherently risky activity. The ISCF presents an opportunity for the government to demonstrate a greater willingness to accept the risk of failure, or perceptions of it, in its innovation support. Consequently, the Academy welcomes the government's recognition that a 100% success rate for the ISCF would suggest the level of ambition had been too low; and that it will be important that there is a broad risk appetite across the portfolio of challenges as well as within elements of each specific challenge.¹⁴
15. A key overarching message in the Academy's submission to the industrial strategy Green Paper was that given the limited resources available, it is crucial that the industrial strategy assimilates and builds on existing successful initiatives, institutions and structures. This principal is applicable to the ISCF. Government will maximise returns on previous investments by ensuring the continued operation of successful activities, as well as spreading best practice and learning derived from them.

The rationale and coherence for the distribution of funding:

- **between the Industrial Strategy Challenge Fund (and its individual ISCF schemes) and the rest of the Science budget;**

16. To reap the maximum benefit from the ISCF, it is essential that it is effectively coordinated with the rest of the Science Budget; both to ensure that positive outcomes can be derived from the ISCF, and to ensure that other complementary research and innovation activities remain well funded and support the new capacity required. A systems view is needed to ensure that ISCF is well aligned with the rest of the Science budget and with wider initiatives intended to contribute towards a positive environment for research and innovation. This entails taking a holistic view of the incentive structures, interventions and policies that impact on the research and innovation system and the investments being made through ISCF.
17. The UK has sometimes tended to 'spread the jam thinly', particularly with regard to innovation support, rather than focus investment on a more limited number of priorities to achieve critical mass in those areas. Ensuring that the investments made through the ISCF are of sufficient size to achieve their intended ambitions, and are not diluted across a large range, small initiatives will be crucial. It will also be important to maximise the level of industrial co-investment within specific sectors across the developing ISCF portfolio, to raise the private sector's contribution to achieving the government's R&D investment ambition. However, as yet, it is unclear what the overall portfolio of the ISCF will be, or how much money has been allocated to the fund.

¹² [How innovation agencies work](#), Nesta, 2016

¹³ [Advice on the ISCF: Innovate UK and BBSRC letter](#), 2017

¹⁴ [Advice on the ISCF: Innovate UK and BBSRC letter](#), 2017

- **between the various initiatives to financially support innovation and commercialisation of research;**

18. Innovation is instrumental in delivering the economic and productivity gains associated with investment in research, and offers a key route to developing new tools and approaches for tackling major societal challenges and improving quality of life. However, innovation stretches far beyond the traditional view of commercialisation of a scientific discovery resulting in a marketable product; innovation can also derive from developments in design, business models and mechanisms of service delivery. Furthermore, innovation is not a linear process: it requires feedback from the market, timely and appropriate investment at critical development points and the interaction of a variety of actors. Consequently, it is appropriate that there are multiple initiatives to support innovation and the commercialisation of research. However, efforts are still required to simplify the interface for those looking for innovation and commercialisation support. Innovate UK has made good progress with its 'no wrong door' approach.¹⁵ It will be important that UKRI embeds this approach across the whole organisation.¹⁶

19. Effective support for innovation and the commercialisation of research needs to connect with relevant policy areas beyond those which BEIS is directly responsible for, with important interfaces to policies on trade, exports, infrastructure, education and skills, immigration, procurement, energy and tax etc. The ability of the UK to achieve longevity of innovation success depends on the support of, and coordination with all government departments.

- **between the two arms of the 'dual support' system – funding via the research councils and funding via Research England;**

20. The 'dual support' system has contributed to the UK's research success. Together, the two components of the dual support system, the Research Councils and quality related (QR) funding from the funding bodies, underpin the UK's academic research base. Therefore, the Academy welcomed the introduction of the 'balanced funding principle' into legislation as part of the Higher Education and Research Act.¹⁷ In light of the increased investment in R&D, including the introduction of the ISCF, strategic consideration needs to be given to ensuring that the two components of the dual support system are adequately resourced and balanced to ensure the ambition of the government's new investments can be achieved.

- **between innovation and research**

21. Innovation is the process by which ideas are converted into value – in the form of new and improved products, services and approaches. It often draws on R&D and may involve commercialisation, but it is not synonymous with either. While technology is a common source of innovation, innovation can also derive from developments in design, business models and mechanisms of service delivery.

22. There is no simple way to measure a country's innovation performance, but the UK consistently ranks within the top ten in most international league tables. Interrogation of the indicators used to compile these rankings reveals strengths relating to the UK's research base and universities, but relative weaknesses in indicators related to innovation outputs.¹⁸ For example, the UK ranks fifth overall out of 127 countries in the Global Innovation Index 2017, yet ranks 28th for knowledge absorption and 38th for knowledge

¹⁵ [Dowling Review of Business-University Research Collaborations, Government Response](#), 2016

¹⁶ [Dowling Review of Business-University Research Collaborations, Government Response](#), 2016

¹⁷ [Royal Academy of Engineering responds to government amendments to Higher Education and Research Bill](#), 2017

¹⁸ [Investing in Innovation](#), Royal Academy of Engineering, 2015

diffusion.¹⁹ While an excellent research base undoubtedly provides the UK with a comparative advantage as a knowledge-based economy, a strong research base does not reflect innovation performance per se and will not deliver the benefits associated with innovation if other aspects of the innovation system are weak.

23. The arguments for public support for innovation have been widely accepted by the UK's global competitors. As a result, the UK faces stiff competition for talent and investment. In this highly competitive and internationalised environment, the role of government in providing an assertive, effective and long-term commitment to innovation and the support of effective translational policies, mechanisms and organisations is more important than ever. The UK has historically underinvested in innovation. The ISCF and more broadly the developing industrial strategy are important steps in readdressing this balance.
24. The creation of UKRI offers the potential for a more coherent, better aligned and longer-term set of policies and approaches focused on research and innovation funding. However, this benefit is counterbalanced by the fact that discontinuity in approaches is important for creating a vibrant innovation system, for example, by ensuring diversity and avoiding group think. Therefore, it will be important to ensure that the opportunities of alignment do not stifle the agility, variety and effectiveness of innovation support. It will also be crucial for Innovate UK to maintain its unique business facing function and close connectivity to its primary customer base of business and entrepreneurs.
25. Within the context of a thriving research and innovation system, engineering has a specific role to play in creating new and better products and services that can generate wealth and improve quality of life. Strategic investment in engineering can yield a significant return on investment for the UK since engineers draw on scientific advances produced all around the world in developing innovations that create wealth for the UK. This is not to say that funding should be diverted away from other disciplines into engineering, nor from research into innovation. Engineering and innovation draw on insights from fundamental research and in turn can open up new avenues for fundamental research – the relationship is symbiotic.
 - **The balance between different parts of the country in Government funding of research/innovation, the effectiveness of such place-based financial support, and how planned place-based funding might affect that balance in future**
26. The growing awareness of the importance of 'place' for innovation, reflected in the introduction of Local Enterprise Partnerships, Growth Hubs and the focus on the Northern Powerhouse and Midlands Engine is welcomed. Regions have different innovation characteristics, determined through a combination of the presence of Higher Education Institutions, the level of skills available, the types of companies present, and, critically, the infrastructure available and its quality. Recognising the differences between these local areas allows policies to be developed which seek to maximise the contribution made by innovation to local growth.
27. Science and Innovation Audits go some way towards addressing this need of mapping the landscape, but there is more to do, particularly to understand industrial activities and map skills. The production of the audits has also emphasised the value of exercises in bringing people together, which is quite distinct from the formal outputs they yield. Our industrial strategy consultation further highlighted a belief that mechanisms for enabling people

¹⁹ [Global Innovation Index 2017](#)

within a region to meet and collaborate was a high priority need that was not yet being met.²⁰ Government should build on the Science and Innovation Audits to develop more comprehensive mapping of local industrial capabilities, including skills, and innovation ecosystems, which would necessitate more industrial engagement in the audits than has sometimes happened. This needs to be accompanied by an ongoing process of stakeholder engagement; the full value of the mapping will not be realised without this.

28. A systems approach needs to be adopted not only to local decisions but also to coordination across the UK. Previous interventions, notably the Regional Development Agencies, resulted in competition between regions to become the lead in one sector. It is clearly neither desirable nor feasible for every region in the UK to be a global leader in, say, nanotechnology or artificial intelligence. National and local strategies and initiatives need to be coordinated and coherent: the whole needs to be greater than the sum of the parts. The landscape for local support is already complex. The focus should be on promoting awareness of what exists, providing a stable framework for support and policy continuity and seeking to build on what works.
29. European funding, particularly the European Regional and Development Fund, has played a significant role in enabling regional investments in support of research, innovation and associated activities. As the UK proceeds with the negotiations to leave the EU, it will be essential that measures are put in place to ensure continuity and that UK funding streams are introduced to support this type of regional development in the future.
- **What further measures the Government should take to use its spending and facilities to strengthen innovation, research and associated 'place'-based growth.**
30. Technological innovations must be extensively tested and demonstrated in real-world environments, if they are to succeed on the market. Such testing also allows for development of key regulations and standards in parallel, which are factors that determine the commercial success of technological innovations. The provision of high-quality testing and demonstration facilities does not have to necessitate the creation of new infrastructure; instead, existing UK infrastructure could be utilised as 'national innovation assets'.²¹ Examples of such assets could be airfields where drones could be tested, hospitals where innovative approaches to data-driven services could be trialled or factories where novel approaches to automation could be implemented. A UK wide register of 'national innovation assets', which can serve as test beds, demonstrators and focal points for skills development, should be compiled and promoted to both UK and international comparators.
31. Facilitation of interactions between academia and industry was identified in our consultation on the industrial strategy as an effective way to incentivise private sector companies to invest in R&D.²² Much work has already been undertaken to understand how to improve the relationships between businesses and the UK's world leading academic research base, including the Dowling Review of Business University Research Collaborations.²³ The creation of UKRI provides the opportunity to implement improvements to business-

²⁰ [Engineering an economy that works for all](#), industrial strategy Green Paper response, Royal Academy of Engineering and Engineering the Future, April 2017

²¹ [Engineering an economy that works for all](#), industrial strategy Green Paper response, Royal Academy of Engineering and Engineering the Future, April 2017

²² [Engineering an economy that works for all](#), industrial strategy Green Paper response, Royal Academy of Engineering and Engineering the Future, April 2017

²³ [Dowling Review of Business-University Research Collaborations](#), 2015

university interactions more broadly.²⁴ Shared facilities between private and public sectors are beneficial for business-university interactions. Current rules mean that publicly-funded research institutes are restricted to 5% commercial activity if they opt not to pay VAT; or they face costly tax bills to co-locate their researchers with industry colleagues. The UK's departure from the EU may have a direct impact on this restriction as European legislation has been identified as the source of the requirement.²⁵

32. Public procurement has the potential to have a disproportionately transformative effect on UK companies; utilising only a small proportion of the procurement budget to target innovative approaches and SMEs could have a huge impact. In light of the EU referendum result and its implications for Regulations, Directives and other EU law currently applicable in the UK, a review is needed of public procurement and state aid rules as part of the industrial strategy.
33. The availability of skills is a key determinant of the ability of different regions to deliver jobs and growth. Concerns about skills shortages was identified as a consistently strong theme across all parts of the UK in our industrial strategy consultation, with 87% of respondents identifying a skills shortage in their sector.²⁶ There is a substantial and urgent task to raise skills levels across the whole of the UK in order to ensure that our workforce remains globally competitive and able to embrace the opportunities enabled by new technology. Our submission to the industrial strategy Green Paper, *Engineering an economy that works for all*, explores skills development in detail.²⁷
34. The diffusion and adoption of innovation by businesses is essential for the UK to reap the benefits of its R&D and innovation investments. Exploring how the diffusion and adoption of innovation by low productivity businesses can be accelerated should be a priority. Absorptive capacity: the ability to recognise the value of new, external information, assimilate it and apply it to commercial ends is key for adoption and dissemination. Therefore, the skills of the workforce are also key to ensuring adoption of innovation is successful. Government can support this process by ensuring that the education system produces a sufficient quantity and quality of graduates and apprentices to populate the future workforce. In addition, while companies clearly need to take much of the responsibility for ongoing training and organisational development, government can use policy levers and co-investment to encourage this.²⁸

²⁴ [Dowling Review of Business-University Research Collaborations, Government Response](#), 2016

²⁵ [Leaving the EU: implications and opportunities for science and research, Seventh Report of Session 2016-17](#), House of Commons Science and Technology Committee, 2016

²⁶ [Engineering an economy that works for all](#), industrial strategy Green Paper response, Royal Academy of Engineering and Engineering the Future, April 2017

²⁷ [Engineering an economy that works for all](#), industrial strategy Green Paper response, Royal Academy of Engineering and Engineering the Future, April 2017

²⁸ [Investing in Innovation](#), Royal Academy of Engineering, 2015