

The Dowling Review of Business-University Research Collaborations

July 2015

Foreword by Jo Johnson MP



This Government is committed to maintaining the strength of the UK's world class research base. Excellent research, as well as being worthwhile in its own right, is vital to tackling the productivity gap that is the foremost economic challenge facing this country.

Business research and development is the foundation of productivity and growth; university research collaborations have a vital role in providing business with new processes and technologies, highly skilled people and access to world-leading experts.

That is why we asked Professor Dame Ann Dowling to consider how we can better support relationships between UK businesses and the UK's world-leading university researchers. We have made much progress but Dame Ann and her team has found we could do more.

The report makes recommendations on reducing complexity, fostering relationships and introducing effective brokerage, particularly for smaller businesses. We need to improve the breadth and range of connections through making it easier to connect. We need to help these relationships endure and reach their potential. For just as our global research excellence has been built up over many years we need to apply the same sustained effort to these relationships, so that businesses can innovate and grow.

I congratulate Dame Ann, the review group and the Royal Academy of Engineering for producing this excellent report against a demanding timescale. We must now show the same commitment and determination to use the fantastic potential of our nation's science and research to make Britain the best place in Europe to innovate, patent the best new ideas and set up and expand a business.

A handwritten signature in black ink, reading 'Jo Johnson' in a cursive style.

Jo Johnson MP
Minister of State for Universities and Science

Executive summary

Strategic business-university research collaborations provide a myriad of benefits to their participants. For academics, these benefits can include the opportunity to address challenging research questions with real-world applications, see their research have tangible impacts and gain access to new skills, data or equipment. Companies can improve business performance through developing new techniques or technologies, de-risk investment in research, and extend the capabilities and expertise available to the firm. Investment in collaborative R&D also delivers real benefits to the UK, driving growth and productivity improvements for firms and high quality research outputs.

It is clear that the UK has played host to many successful business-university collaborations. Yet it is also clear that the UK is not reaping the full potential provided by the opportunity to connect innovative businesses – from the UK and overseas – with the excellence in the UK’s academic research base. Government has a crucial role in fostering the conditions under which these collaborations can happen at scale and deliver enduring impacts for all parties involved.

The key messages from this review are therefore:

Public support for the innovation system is too complex.

Business-university collaboration is an important component of the innovation ecosystem. Innovation is a complex, non-linear process, so the complexity of the UK’s innovation ecosystem is not surprising and may be to a degree inevitable. However, the complexity of the policy support mechanisms for research and innovation poses a barrier to business engagement in collaborative activities, especially for small businesses. It also makes it difficult for government to take a systems view of its support mechanisms for research and innovation. The over-arching recommendation of this review is therefore that government should seek to reduce complexity wherever possible and, where simplification is not possible, every effort should be made to ensure that the interface to businesses and academics seeking support for collaborative R&D is as simple as possible, even if internally the system of schemes is complex: a process that has been referred to as ‘hiding the wiring’.

People are central to successful collaborations.

Strong, trusting relationships between people in business and academia form the foundation for successful collaboration. These relationships require mutual understanding and a common vision for the benefits that can be derived from the collaboration. Such relationships can be fostered by creating an incentive framework for universities and businesses which promotes the transfer of ideas and people between business and academia. This includes supporting students to develop business awareness at an early stage of their research careers, continuing to fund schemes which support mobility between academia and business and ensuring that researchers who are successful in collaborations are valued in terms of career progression and assessment of research output.

Effective brokerage is crucial, particularly for SMEs, and continued support is needed for activities that help seed collaborations.

This brokerage requires digital tools to facilitate the identification of potential research partners, complemented by clear signposting and access to support from appropriately

informed people – at present, no UK-wide service exists that adequately addresses this need. It is also essential that funding is available to kick-start collaborations. Innovate UK and the Research Councils currently provide a number of schemes to help with this. Schemes which tend to be considered particularly valuable in this respect are those which underpin small-scale projects, such as Knowledge Transfer Partnerships and CASE studentships, and those which can be deployed flexibly and rapidly in response to emerging opportunities, such as Higher Education Innovation Funding and Impact Acceleration Accounts.

Pump-prime funding would stimulate the development of high quality research collaborations with critical mass and sustainability.

The UK has a vibrant research environment, with a range of collaborations taking place between universities and businesses across many disciplines, but there is more to be done to help existing efforts evolve from short-term, project-based collaborations to longer-term partnerships focussed on use-inspired research. Providing such help will not only result in increased benefits for business, as academics are able to more confidently explore areas of business interest, but also offers the chance to drive new insights in areas of fundamental research. There is a gap in the market to encourage business-university research collaborations to grow. Funding is needed to enable the creation of a critical mass of use-inspired research activity within universities, to help unlock the full strategic potential of collaborative relationships. Experience with existing schemes suggests that a very favourable return on the public investment could be achieved over the lifetime of such a scheme.

Technology transfer offices need to prioritise knowledge exchange over short-term income generation, and further work is required to improve approaches to contracts and IP agreements.

Universities have rightly become more aware of the importance of intellectual property and have significantly professionalised their knowledge exchange activities. However, there is a tension between the desire to earn short-term income from their IP and the need to deliver wider public benefit, and potentially greater long-term return on investment from this IP. The emphasis needs to shift towards the latter, and this must be reflected in technology transfer office funding models and success metrics. Notwithstanding the substantial work already undertaken to improve approaches to establishing contracts and IP agreements, this area remains a major source of frustration for both academics and businesses.

Government strategy on innovation needs to be better coordinated and have greater visibility.

Research and innovation have a central role to play in supporting industrial strategy and universities should be seen as key partners in its development and delivery. Government has an opportunity to use industrial sectors and key technologies as levers to encourage greater business investment in innovation and R&D and to involve companies of all sizes through the supply chain. It also needs to ensure that the tax system effectively encourages collaborative research. At a local level, government has given Local Enterprise Partnerships a remit to support innovation within their area but performance to date has been patchy and there is a need to set a clear national direction and provide stronger support to enable them to fulfil this role.

This review has benefitted from the great enthusiasm of those in the business and academic communities with an interest in collaboration. There is evidently a huge amount of goodwill and drive to make collaborations happen. With appropriate, and in many cases catalytic, public support and an effective policy framework, this can be translated into substantial benefits for the UK through the development of innovative products and services and improved competitiveness and productivity.

Recommendations

Public support for the innovation system is too complex.

1. The UK's research and innovation support system has become excessively complex. Government and its funding agencies should seek to reduce complexity wherever possible, for example by consolidating schemes with similar aims. Where simplification is not possible, every effort should be made to 'hide the wiring' from businesses and academics seeking support. [Govt/RCs/IUK/FCs]¹

People are central to successful collaborations.

2. The evidence so far is that the inclusion of Impact in the REF has helped to stimulate a more positive attitude amongst academics towards collaboration with business. Successor exercises to the REF 2014 should:
 - a. Maintain or increase the weighting given to Impact;
 - b. Provide more explicit recognition for staff who have moved between industry and academia in either direction, or 'discipline-hopped'; and
 - c. Consider universities' industrial collaborations, including the exchange of people and the success of their translation activities, as an important part of the 'Environment' component. [FCs]
3. The perception that collaborating with industry, or spending time in industry, is damaging to an academic career path persists and detracts from the attractiveness of such activities for academics. Universities need to ensure that recruitment and promotion criteria for relevant disciplines reward rather than penalise academics who have achieved excellence in translational and collaborative activities, and that these messages are communicated effectively. [Univs]
4. Universities must be robust in the promotion and implementation of their institutional conflict of interest policies to help protect individual researchers who receive funding from industry against personal criticisms based on misconceptions about the role of industry in this research. The wider research community, including the Research Councils and Innovate UK, needs to be more proactive in engaging with the media to discuss the significance of industry funding for academic research. [Univs/RCs/IUK]
5. There is an ongoing challenge to engage those companies that have never participated in collaborations but could profit from doing so. A campaign raising awareness of the benefits that companies have derived from university collaboration could play a helpful role in stimulating a broader base of demand. [Govt/IUK]
6. Innovate UK, collaborating with others as appropriate, should develop a system of peer-to-peer advice for business leaders seeking to get involved in collaborative research or innovation for the first time. [IUK]

¹ Organisation categories in square brackets indicate primary target(s) of recommendation: Bus (business); FCs (Funding Councils); Govt (government); IPO (Intellectual Property Office); IUK (Innovate UK); RCs (Research Councils); TTOs (university Technology Transfer Offices); Univs (universities). Recommendations grouped by target can be found in Annex E.

7. Funding bodies and universities should do more to promote examples of researchers who have derived particular benefit from collaborating with industry. [FCs/RCs/IUK/Univs]
8. For academics in relevant disciplines, spending time in industry should be seen as a mark of esteem that enriches their career, analogous to gaining international experience. Universities and research institutions should expect newly appointed Principal Investigators in such disciplines to gain industrial experience (if they do not already have any), and funding agencies should ensure that grant conditions encourage this. [Univs/RCs]
9. Forming connections with business at the outset of an academic career path could significantly enhance the environment for collaboration over the longer-term. To enhance doctoral training:
 - a. Universities should ensure that all PhD students in appropriate subjects receive IP awareness and wider business skills training;
 - b. The Research Councils and other major funders of PhD studentships should support students in appropriate subjects to spend some time in business as part of their doctoral training; and
 - c. Universities should play an active role in facilitating industrial placements for their PhD students. [RCs/Univs]

Effective brokerage is crucial, particularly for SMEs, and continued support is needed for activities that help seed collaborations.

10. The Higher Education Funding Council for England (HEFCE), Innovate UK and the Research Councils are working with the National Centre for Universities and Business (NCUB) to develop an online brokerage platform. To be effective, brokerage services need to:
 - a. Include data on business-university partnerships that are funded by industry, charities or international agencies, as well as public funders such as the Research Councils and Innovate UK;
 - b. Provide information on potential sources of funding and support;
 - c. Be accessible to a non-specialist audience;
 - d. Be complemented by access to well-informed personnel;
 - e. Have a clear evaluation framework to enable assessment of whether the portal has achieved the objectives set; and
 - f. Be communicated pro-actively and energetically. [FCs/IUK/RCs]
11. The Catapult system is now an integral part of the UK's innovation landscape. To reap the benefits:
 - a. The system needs to continue to receive long-term, sustained support from government;
 - b. The metrics used to evaluate Catapults' performance should include indicators that capture the success of their engagement with universities;
 - c. Gradual growth in the number of Catapults would be beneficial, but any growth in Catapult numbers should only occur if additional funding is available and should not be at the expense of the support assigned to existing Catapults. [Govt/IUK]
12. The government needs to address the issue of VAT on shared facilities as a matter of urgency. [Govt]

13. The Research Councils and Innovate UK should build in sufficient time in their advertisement of calls for proposals where industry may be a partner in order to ensure that all companies who wish to participate have reasonable opportunity to do so and there is time for new research partnerships between businesses and universities to be put together. [RCs/IUK]
14. Knowledge Transfer Partnerships (KTPs) have proved to be highly valuable for facilitating knowledge transfer and seeding collaborations. Innovate UK should increase levels of KTP funding to enable it to better meet demand for the scheme, as well as ensuring that the burden on applicants is proportionate to the size of the grant. [IUK]
15. CASE studentships are highly valued tools for establishing partnerships between industry and academia. The Research Councils should: use a standard model for allocation of and eligibility for CASE studentships and synchronise timelines wherever possible; and increase the availability of CASE studentships to SMEs and to new business-university partnerships. [RCs]
16. Higher Education Innovation Funding (HEIF) is an important and much valued funding mechanism for supporting universities' capacity to engage with businesses. Government should make a long-term commitment to maintaining a form of flexible funding for knowledge exchange as a means of stimulating translational activity and collaboration. [Govt/FCs]
17. Impact Acceleration Accounts (IAAs) have also proved effective and should be offered across all the Research Councils. The approach to allocating or applying for IAAs should be common across the Research Councils. [RCs]

Pump-prime funding would stimulate the development of high quality research collaborations with critical mass and sustainability.

18. There is a need for a new public and private co-funded scheme that would provide pump-priming funds on a competitive basis to enable strong relationships between individuals in academia and industry to transition into group collaborations with critical mass, substantial industry funding and a long-term horizon. These 'Awards in Collaborative Excellence' (ACE) would make a substantive contribution to scaling up the overall collaborative effort in the UK. [Govt/RCs/IUK]

Technology transfer offices need to prioritise knowledge exchange over short-term income generation, and further work is required to improve approaches to contracts and IP agreements.

19. University Technology Transfer Offices (TTOs) are important players in the collaboration process. In order to strengthen the role that they play:
 - a. Universities should ensure that the overarching metric used to assess the success of TTOs is their effectiveness in supporting translational activities over the longer term, not short-term revenue generation.
 - b. Universities that are confident of the performance of their TTO in supporting the establishment of collaborations should publicise statistics that highlight their efficiency and effectiveness.
 - c. TTOs and universities should work collaboratively, across institutional boundaries, to share expertise, sector knowledge and best practice. [Univs/TTOs]

20. The Intellectual Property Office (IPO) and Department for Business, Innovation and Skills should define principles for commercial use of background IP created through publicly-funded research. [IPO/Govt]
21. The Research Councils and Innovate UK should build on their own successful experiences and invoke template agreements wherever appropriate. [RCs/IUK]
22. Innovate UK, in consultation with the IPO, should explore the establishment of an independent source of advice and expertise that SMEs could call upon for support in negotiating contracts with universities. [IUK/IPO]
23. There is scope for all parties, including the Research Councils, Innovate UK, funding councils, universities, businesses and organisations which represent TTOs, to promote examples of better practice in relation to IP and contracts and facilitate their utilisation across the community. [RCs/IUK/FCs/Univs/TTOs/Bus]

Government strategy on innovation needs to be better coordinated and have greater visibility.

24. When developing industrial strategy and other long-term sectoral strategies, government and business should consult universities as key partners. Innovation should be a core component of policies aimed at promoting productivity and competitiveness, with full consideration given to its role in different sectors. [Govt/Bus]
25. Government should prioritise increasing public investment in R&D in industrial sectors of strategic importance, conditional on a commensurate increase in investment in associated activities by business. Innovate UK should be tasked with monitoring investment levels in R&D across industrial strategy sectors and managing the matched funding stream from government. [Govt/Bus/IUK]
26. A commitment for a sector-wide increase in business investment in R&D and associated activities should be a qualifying condition for the admission of new sectors to the industrial strategy (subject to the government co-investment referred to in recommendation 25). [Govt/Bus]
27. Much clearer guidance from HM Revenue and Customs and the Department for Business, Innovation and Skills (BIS) is needed for businesses on how they can make best use of R&D tax credits and how these interplay with State Aid restrictions. [Govt]
28. Government and sector leadership councils should ensure that industrial strategy sector activities build in opportunities to support pre-competitive research on a collaborative basis. [Govt/Bus]
29. Government should maximise the opportunities provided by the Small Business Research Initiative (SBRI) to foster business-university collaboration, including by facilitating the formation of new partnerships for commercial exploitation amongst potential bidders. [Govt]
30. The NHS needs to be considered a key part of innovation frameworks within the UK, becoming an early adopter of emerging drugs and technologies, and facilitating business-university research collaborations. [Govt]

31. BIS and the Department for Communities and Local Government (DCLG) need to set out clear guidance on supporting innovation at a local level, which Innovate UK should be actively involved in developing and communicating. [Govt/IUK]

32. Innovate UK, with support from BIS and DCLG, should be tasked with ensuring that the innovation strategies at local levels make sense nationally and that collaboration, rather than competition, between Local Enterprise Partnerships (LEPs) is the dominant modus operandi. [IUK/Govt]

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1. State of play: collaborative research in the UK

Introduction to the Review

1. On 12 December 2014, I was asked by the then Minister for Universities, Science and Cities, Rt Hon Greg Clark MP, to lead a review examining business-university research collaborations.² Further detail on the expected focus of the review was provided in a letter from the Permanent Secretary of the Department for Business, Innovation and Skills (BIS), Martin Donnelly CMG, on 19 December (see Annex A). The deadline set for reporting was early Summer 2015, in order for the report to be ready to issue to new Ministers following the General Election.
2. As highlighted by Figure 1, business-university collaboration has been an exceptionally popular target for reviews and studies in recent years. This is not surprising given the significance of research and innovation as drivers of a knowledge-based economy, coupled with longstanding concerns regarding the UK's overall level of investment in R&D, its performance in converting research excellence into commercial success, and the need to boost UK productivity.³
3. The imperative for a further review at this particular juncture is two-fold. The first issue is one of timing. There have been several important developments in the UK research and innovation landscape in recent years, including: the growth in innovation funding through Innovate UK; establishment of the network of Catapults; the evolution of a modern industrial strategy; introduction of Local Enterprise Partnerships (LEPs); and the conclusion of the first Research Excellence Framework (REF). Looking forward, there is an ongoing challenge to ensure that research and innovation play their full part in promoting UK prosperity and well-being, and are supported at the levels required to achieve this effectively, despite the constraints on public finances. A review of the current state of play in the UK and what can be done to maximise future performance is therefore timely.
4. The second key driver for this review, and an important differentiator from some of the other reviews listed in Figure 1, is the focus on promoting strategic, longer-term research collaborations between universities and businesses. This restricted scope, coupled with the tight timeframe for reporting, has resulted in a very targeted approach which focuses on how the UK can take best advantage of the opportunity to expand the numbers of strategic research partnerships between universities and businesses across all areas of the country, disciplines and sectors, and all types of business, in order to scale up the benefits delivered to both the participants in the collaboration and the nation as a whole.
5. There are of course differences between the experiences and opportunities encountered by large and small businesses, and between disciplines and sectors. For example, 'long-term' partnerships in a sector such as aerospace can span decades, while in the creative

² The terms 'business' and 'industry' are used interchangeably in this report

³ See, for example: *Insights from international benchmarking of the UK science and innovation system*, Department for Business, Innovation and Skills, 2014, p7, which describes "average to low levels of new to market innovations", despite the strength of the UK's research base. Also: *The UK's Innovation Deficit & How to Repair it*, University of Sheffield Political Economy Research Institute, 2013, p2; *Research and development*, House of Commons Library, 2014; *Policy briefing: Science and Engineering Investment*, Campaign for Science and Engineering, 2015; *Business-university collaboration*, House of Commons Business, Innovation and Skills Committee, 2014.

Figure 1
Recent Reviews addressing Business-University Collaboration



industries a long-term collaboration might last for two to three years. In addition, there is no expectation that academics in all research disciplines should participate in collaborations with business. Where appropriate, these differences have been taken into account, though it is worth saying that very many of the key conclusions and recommendations that emerged from the review proved to have rather broad relevance.

6. I have been fortunate to have excellent support in carrying out this review. I have worked closely with my review group, which includes leading experts drawn from a wide spectrum of disciplines and types of organisation (the membership is at Annex B), and with the secretariat hosted by the Royal Academy of Engineering, and I would like to record my appreciation for their important contributions.
7. I am also very grateful for the positive engagement by so many in the business, research and innovation communities during the consultation phase of the review, especially in view of the challenging timescales. I would particularly like to thank those who hosted and arranged consultation meetings for the review, which enabled me to hear a wide range of perspectives from across the country.

The consultation

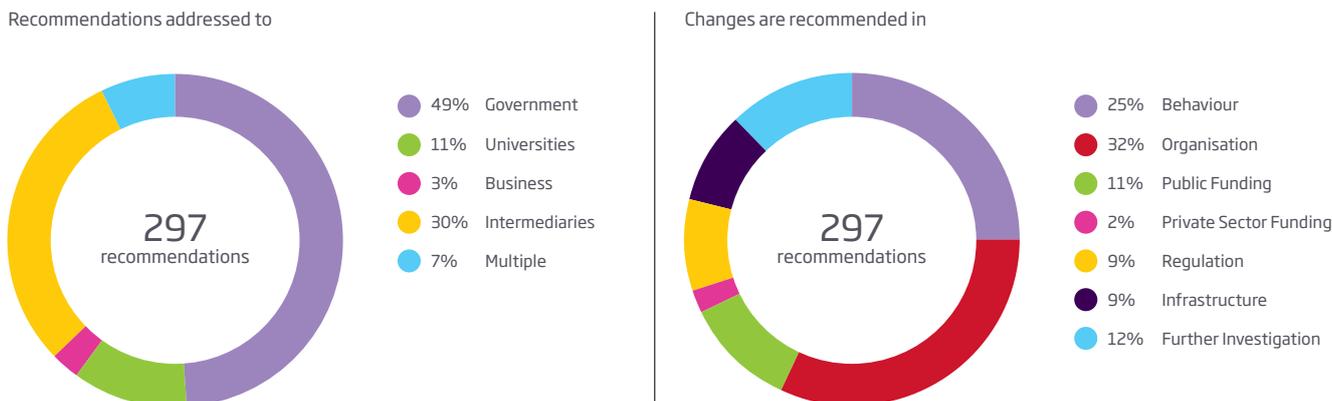
8. A call for evidence was circulated extensively, along with a shorter template targeted at respondents from business (Annex C). 215 written submissions were received from a very diverse group of stakeholders. This written evidence was supplemented by events in Cardiff, Liverpool, Strathclyde and London, where I had the opportunity to hear from academics, businesspeople and technology transfer professionals. Members of the review group, the secretariat and I also participated in a range of meetings and discussions, including with the Confederation of British Industry’s Inter-Company Academic Relations Group (ICARG), National Centre for Universities and Business (NCUB), Academy of Medical Sciences, Research Councils, Innovate UK and Higher Education Funding Council for England (HEFCE). In addition, members of the review group played an important role in eliciting input from businesses on a one to one basis. Figure 2 summarises the consultation process and profile of contributors; a list of contributors is at Annex D.

9. In conducting this review, I was keen to build on the valuable prior work carried out in this area and benefitted from helpful conversations with both Sir Richard Lambert and Sir Andrew Witty. I also spoke to Sir Paul Nurse who is currently undertaking a review of the Research Councils. In addition, an analysis of the key recommendations from nine of the most significant past reviews was provided by NCUB. This searchable tool is now available on the Dowling Review website, and some high-level findings are presented in Figure 3 and Box 1.⁴

Figure 2
Summary of Dowling Review consultation activities



Figure 3
Analysis of business-university reviews’ recommendations, 2010–2015⁵



⁴ <http://www.raeng.org.uk/policy/dowling-review>

Box 1. An Overview of the NCUB Review of Reviews

As shown in Figure 3, the 9 reviews analysed made a total of 297 recommendations, nearly half of which were directed at government. The recommendations cluster into seven broad categories:

- Behaviour changes, for example sharing best practice on approaches to collaboration in Catapults or LEPs, publishing data on spending or numbers of projects, or improved communications;
- Organisational or strategic changes, including development of sector strategies and the Science and Innovation Strategy, and recommendations on Catapult ways of working or Key Performance Indicators (KPIs);
- Public sector funding, for example increasing overall spending on R&D, increased funding for Innovate UK or Catapults, or further funding for specific schemes (such as HEIF);
- Private sector funding, for example ensuring that finance markets are working effectively or measures to increase private sector spending on R&D;
- Regulatory changes, including changes to the planning system, regulations governing the work of local authorities or LEPs, VAT, and public sector procurement rules;
- Infrastructure, for example new online platforms for collaboration, single points of contact in institutions and funding for physical infrastructure provision; and
- Further reviews or consultations, for example on the effectiveness of specific schemes (such as the KTN or SBRI) or the ways in which organisations/schemes engage with SMEs.

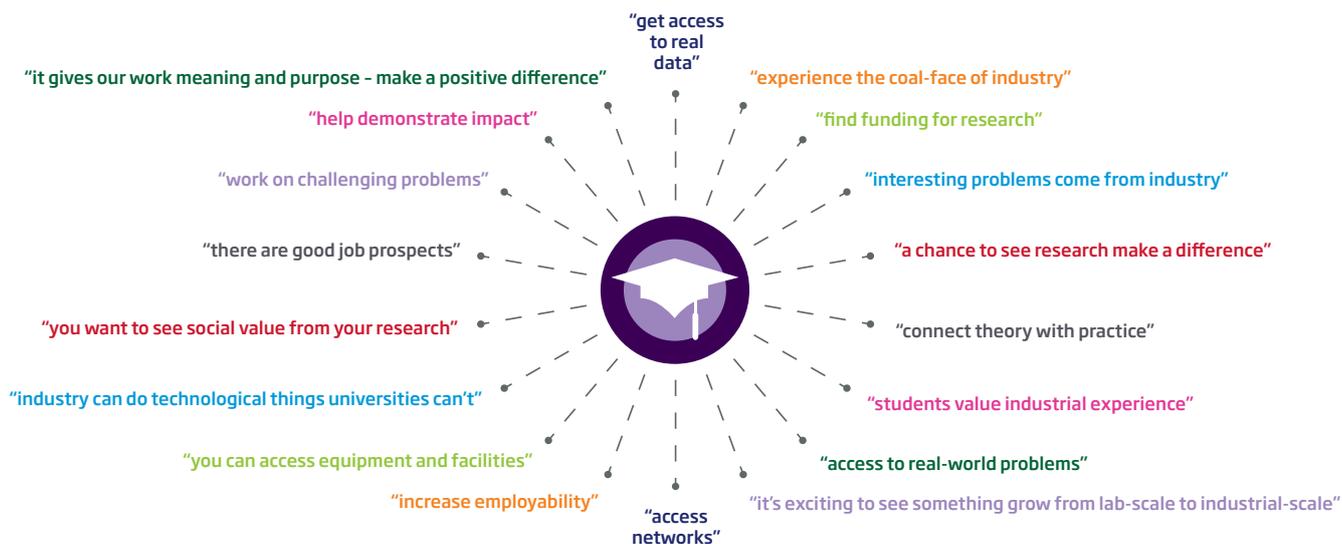
The Dowling Review revisits a number of topics addressed in previous reviews, including knowledge exchange funding, local support for business and mobility across the academia-business interface, for while progress has been made in many cases, there is undoubtedly scope – and a need – for further improvement.

The case for collaboration

10. Strategic research partnerships can provide a myriad of benefits to the participants. The strength of engagement by contributors to the review, from large and small companies and across a wide range of academic institutions, is in itself an indicator of the importance attached to this topic by a broad cross-section of the research community. Moreover, there was widespread agreement across all types of contributor that strategic research collaborations can be highly rewarding activities to participate in, both personally and professionally.
11. Figure 4 depicts some of the most commonly cited motivations for collaboration by academics who contributed to the review. These ranged from the sense of satisfaction that came from working on 'real-world' problems and seeing their research have tangible impacts, to the opportunity to access data, equipment, expertise or networks beyond those available to them in the academic community. Collaboration with industry also opens up new avenues of funding for academic research. The enthusiasm for collaboration expressed by the researchers who participated in the academic workshop

⁵ NCUB collated and analysed the recommendations from selected publications since 2010 which address business-university collaboration. The reviews analysed were: *Best of Both Worlds*, CBI, 2015; *Growing Value: Business-University Collaboration for the 21st Century*, NCUB, 2014; *Business-University Collaboration*, House of Commons Business, Innovation and Skills Committee, 2014; *Review of the Catapult network*, Dr Hermann Hauser, 2014; *Encouraging a British Invention Revolution: Sir Andrew Witty's Review of Universities and Growth*, 'The Witty Review', 2013; *Bridging the Valley of Death: improving the commercialisation of research*, House of Commons Science and Technology Committee 2013; *No Stone Unturned*, Lord Heseltine, 2013; *Tim Wilson's Review of Business-University Collaboration*, 'The Wilson Review', 2012; *The Current and Future Role of Technology and Innovation Centres in the UK*, Dr Hermann Hauser, 2010.

Figure 4
Academics' motivations for engaging in collaboration with business⁶



held to inform this review was particularly striking, and the participants seemed to derive real benefit from the opportunity to share experiences of collaboration across research disciplines and sectors. Unfortunately, despite the clear demand for a more regular forum of this nature, no organisation seemed to see it as their responsibility to take the lead in making this happen. There may therefore be a role for an organisation such as NCUB, working with partners as appropriate, to provide more regular opportunities for academics engaged in industrial collaboration to share experiences and good practice across research disciplines and business sectors.

12. It was similarly encouraging to find strong enthusiasm amongst both SMEs and larger companies for the benefits offered by collaboration. These included access to a pool of talented graduates for potential recruitment, the development of new techniques or processes that could enhance business efficiency, and de-risking investment in new areas of research. In addition, collaboration was seen as important for extending a firm's network and enabling it to obtain a wider range of insights, unconstrained by the company paradigm. Clearly, there is a possibility that the companies that contributed to the review tended to be those that were already convinced of the benefits of collaboration, but efforts were made to also engage those without prior experience of collaboration. Some of these companies acknowledged they could be missing an opportunity by not engaging more with universities but were unable or unwilling to invest the effort required to navigate the UK research base and funding systems in order to initiate a collaboration.
13. Investing in R&D offers the prospect of a range of benefits to businesses. Firms with persistently higher levels of R&D investment have, on average, 13 per cent higher productivity than those with no R&D spending. Innovative firms are also more likely to be active exporters and achieve better value added per employee.⁷ Firms which are more 'innovation intensive' exhibit faster growth, and it has been estimated that 51 per cent of

⁶ Motivations for engaging in collaboration with business mentioned by academics attending the academic workshop as part of the Dowling Review consultation process

⁷ *Our plan for growth: science and innovation evidence paper*, Department for Business, Innovation and Skills, 2014, p17

labour productivity growth between 2000 and 2008 could be attributed to innovation. There is also evidence that collaborative research delivers greater benefits to firms and higher quality research outputs than research conducted either within an individual firm or on an academic basis alone.⁸

14. In addition to the benefits derived by individual firms or researchers, collaboration can make an important contribution to UK economic development. Government has a clear role here, with an opportunity to use industrial strategy as a lever to create an innovation-friendly environment and to use public-funding to help encourage risk-taking by businesses in relation to investment in innovation. Public sector investment in R&D is not 'deadweight': it does not replace funding that would otherwise be financed privately. Evidence shows that business-financed R&D intensity is greater where government-financed R&D is greater.^{9 10} Collaborative R&D also has a positive effect on productivity at the firm level, and there is evidence that when trying to stimulate innovation in the private sector, collaboration delivers enhanced benefits compared to other, more 'closed', forms of innovation.^{11 12} An analysis of Innovate UK's collaborative R&D funding found business impacts to be twice as high for projects with two or more academic partners, at £9.67 Gross Value Added (GVA) per pound spent, compared to projects without academic partners, at £4.22 GVA per pound.^{13 14}

15. Ensuring the UK innovation system is able to support productive collaborations between universities and businesses is therefore key to enabling the world class research produced by our universities to be harnessed to support the business innovation which results in broader economic returns for both individual firms and the UK as a whole. The UK has a world-leading academic research base which can provide an invaluable source of expertise, creativity and insight for businesses that are willing and able to take advantage of it. By connecting businesses to the excellence in the research base, collaboration can play a role in supporting long-term economic growth in the UK. It can help to ensure that the research activity in our universities informs and supports the development of innovative services and products that create wealth and social benefit, as well as improving the competitiveness and productivity of the UK businesses that participate in the collaboration.

16. While the focus of this review is on collaborations that take place in the UK, it is important to recognise that the highly internationalised nature of business has a bearing on the collaboration environment. The globalised nature of business now means that choosing where to locate economic activity, in particular high value-added activity, is of great commercial and strategic significance, and the UK has to compete with many other countries for business investment in R&D. The strength of the UK research base is an important attractor for inward investment and it can be argued that this type of investment can be both high value and relatively 'sticky', especially if those international investors have translational capabilities in the UK.¹⁵

⁸ *Innovation report 2014*, Department for Business, Innovation and Skills, 2014

⁹ *Insights from international benchmarking of the UK science and innovation system*, Department for Business, Innovation and Skills, 2014, Annex D; Also: *The economic significance of the UK science base*, Haskel, J., Hughes, A. & Bascavusoglu-Moreau, E., 2014.

^{10 11} *Estimating the effect of UK direct public support for innovation*, Department for Business, Innovation and Skills, 2014

¹² *Estimating the effect of UK direct public support for innovation*, Department for Business, Innovation and Skills, 2014; *The Impact of Direct Support to R&D and Innovation in Firms*, NESTA, 2013; *Evaluation of the Collaborative Research and Development Programmes*, Innovate UK, 2013

¹³ *Evaluation of the Collaborative Research and Development Programmes*, Innovate UK, 2013

¹⁴ The spillover-benefits from such investment can also be significant, though are difficult to measure. For example: *Insights from international benchmarking of the UK science and innovation system*, Department for Business, Innovation and Skills, 2014, Annex D

¹⁵ *Leverage from public funding for science and research*, Department for Business, Innovation and Skills, 2013, p54; *Russell Group response to Business, Innovation and Skills Committee inquiry*, Russell Group, 2014, p4; *Engineering for a successful nation*, Royal Academy of Engineering, 2015, p5

Current status of collaboration in the UK

17. Although one of the primary purposes of a review such as this is to identify ways of improving performance, it is important to state that there are many positive features of our current performance in collaborative R&D. For example, according to the World Economic Forum, the UK ranks fourth in the world for university-industry collaboration in R&D.¹⁶ However, the UK fares less well on other measures, such as the number of academic/corporate co-authored publications and university interactions with SMEs.¹⁷
18. As part of a review of the economic impact of engineering research, the Royal Academy of Engineering and Engineering and Physical Sciences Research Council commissioned the consultancy Technopolis to undertake an analysis of over 500 engineering research 'Impact' case studies that were submitted to the recent Research Excellence Framework (REF) assessment.¹⁸ These provided a striking illustration of the differential levels of engagement by companies – some companies were cited over and over again in the case studies, while others, of similar size and focus had much lower representation (Figure 5). The case studies quantify the substantial benefits derived by some companies from university research that has led to the development of profitable new products or services.¹⁹
19. For the purposes of this review, Technopolis was asked to extend its analysis of Impact case studies to encompass all disciplines of research addressed in the REF; the results are depicted in Figure 6. Each organisation shown has been mentioned in at least five case studies; some case studies mention multiple companies. It is not possible to directly conclude that the mention of a company means that it has been involved in a research collaboration with the relevant university, but it is reasonable to assume that in general they have been close enough to be aware of, and in many cases to have benefited from, the research cited in case studies. Collectively, the data can be taken as a snapshot of businesses that have engaged with the UK research base resulting in economic, environmental and/or social impacts during the period addressed by the REF.
20. Across all panels 171 companies are mentioned in more than five case studies, with ten companies featuring in all panels. The physical sciences and engineering panel was associated with the largest number of companies, followed by the social sciences, life sciences and humanities panels, in that order. For the life sciences, interactions seem to focus on a relatively small number of companies: 22% (102) of company citations are accounted for by just two companies. By comparison, the two most frequently cited businesses for the physical sciences and engineering panel accounted for 7.9% (75) of all company citations in the case studies reviewed for that panel. Again, the absence or under-representation of some well-known companies from the word clouds suggests that while numerous businesses have enjoyed productive partnerships with the UK research base, there are many other companies that have not embraced this path so enthusiastically.
21. Alongside this analysis, I wrote to Vice-Chancellors of research active universities to ask them to provide an overview of their current long-term research collaborations with industry. One of the notable outcomes of this exercise was a realisation that universities varied enormously in the method by and extent to which they captured this information,

¹⁶ *The Global Competitiveness Report 2014–2015*, World Economic Forum, 2014.

¹⁷ *Insights from international benchmarking of the UK science and innovation system*, Department for Business, Innovation and Skills, 2014; *Response to the Business, Innovation and Skills Committee inquiry on business-university collaboration*, Royal Society, 2014.

¹⁸ *Assessing the economic returns of engineering research and postgraduate training in the UK*, Technopolis Group, 2015

¹⁹ <http://www.ref.ac.uk/>

²⁰ Font size is proportional to the number of times a company is cited, however, font size comparisons cannot be made between panels. The analysis was completed by Technopolis and a methodological note is available on the Dowling Review website: <http://www.raeng.org.uk/policy/dowling-review>.

Figure 5
Companies mentioned in 5 or more Engineering REF Impact case studies

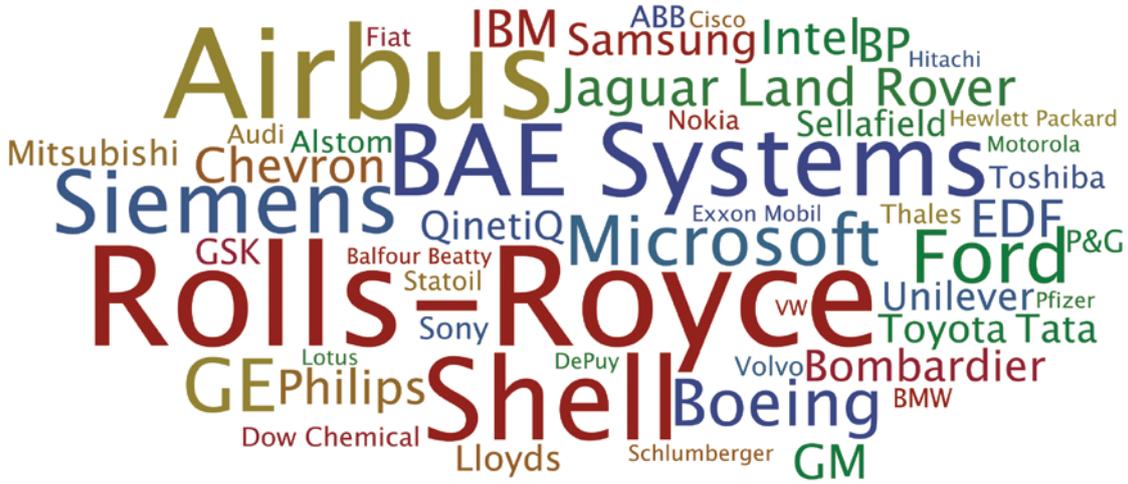


Figure 6
Companies cited in 5 or more REF Impact case studies²⁰
All panels (171 companies)



Main Panel A - Life Sciences (39 companies)



Main Panel B – Physical Sciences and Engineering (76 companies)



Main Panel C – Social sciences (53 companies)



Main Panel D – Humanities (26 companies)



with some finding it near impossible to provide a ready answer to the question posed. While universities are required to submit data on their income from business collaboration to HEFCE, they are not asked to provide information on which companies they collaborate with or the nature of these collaborations. It would nevertheless seem advisable for universities to be able to understand their own collaboration landscape. Moreover, new collaborations could be encouraged if successes were publicised more widely. Interactions with businesses during the course of review also suggested that there was significant variation in the extent to which they were able to take an overview of their strategic relationships with universities.

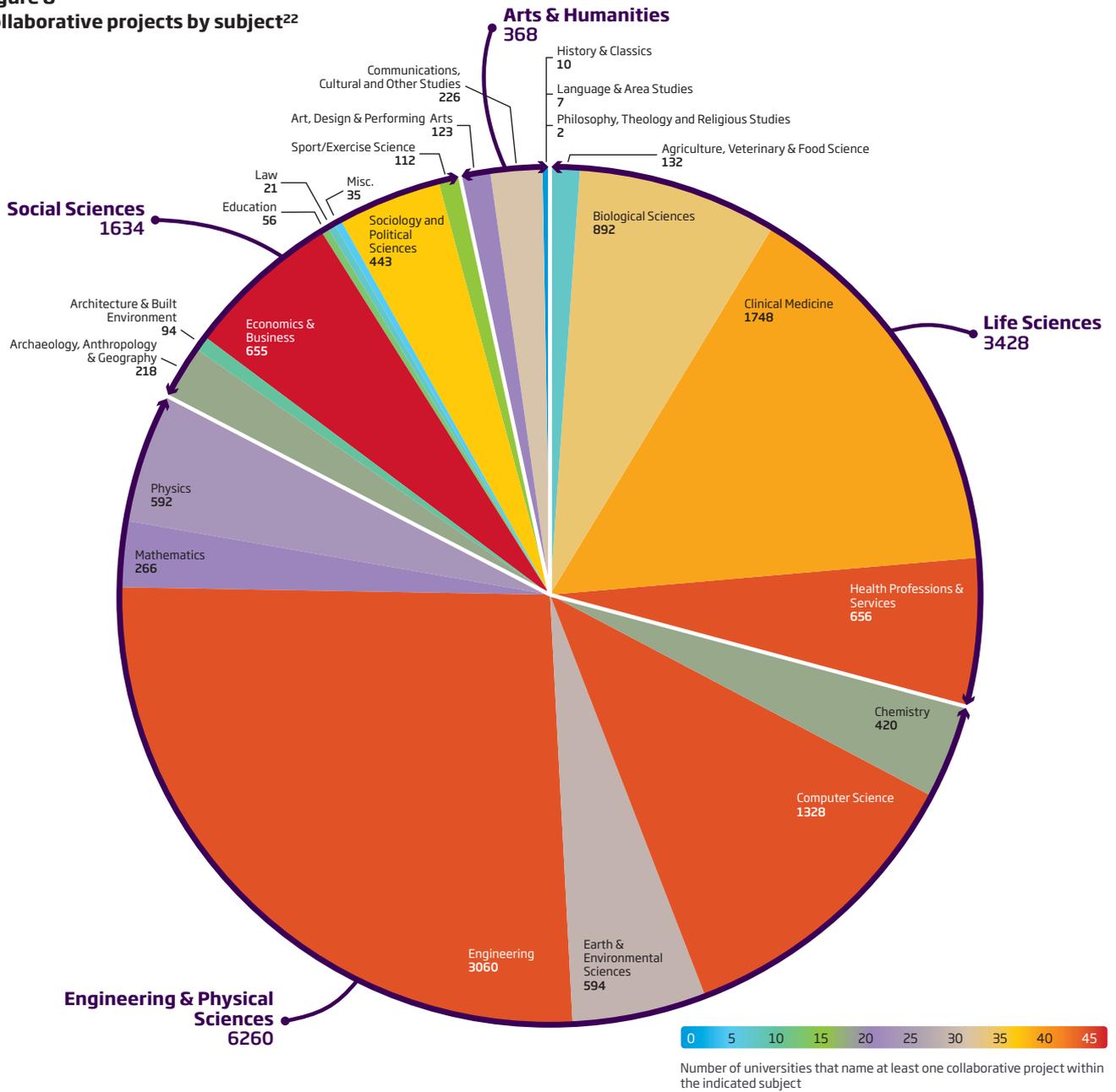
22. 91 responses to the request for data were received, 68 of which were suitable for further analysis, representing c. 50% of UK higher education institutions (HEIs). Because of the issue alluded to above, the data was of variable quality and incomplete in its coverage of universities. These caveats notwithstanding, an interesting picture emerged regarding the representation of companies and sectors in the 12,240 collaborative projects reported. The companies involved in the greatest number of collaborations are notably similar to the most highly cited companies from the REF case study analysis, as shown in Figure 7, suggesting that reference to a company in a REF Impact case study provides a good proxy measure for establishing who is a collaborative partner.

Figure 7.
Top 15 companies by REF analysis and collaboration data²¹



²¹ This graph shows the 15 most frequently cited companies from the REF impact case study analysis and the data on collaborative projects provided by universities. NB. The absolute numbers of citations vary considerably between the two datasets.

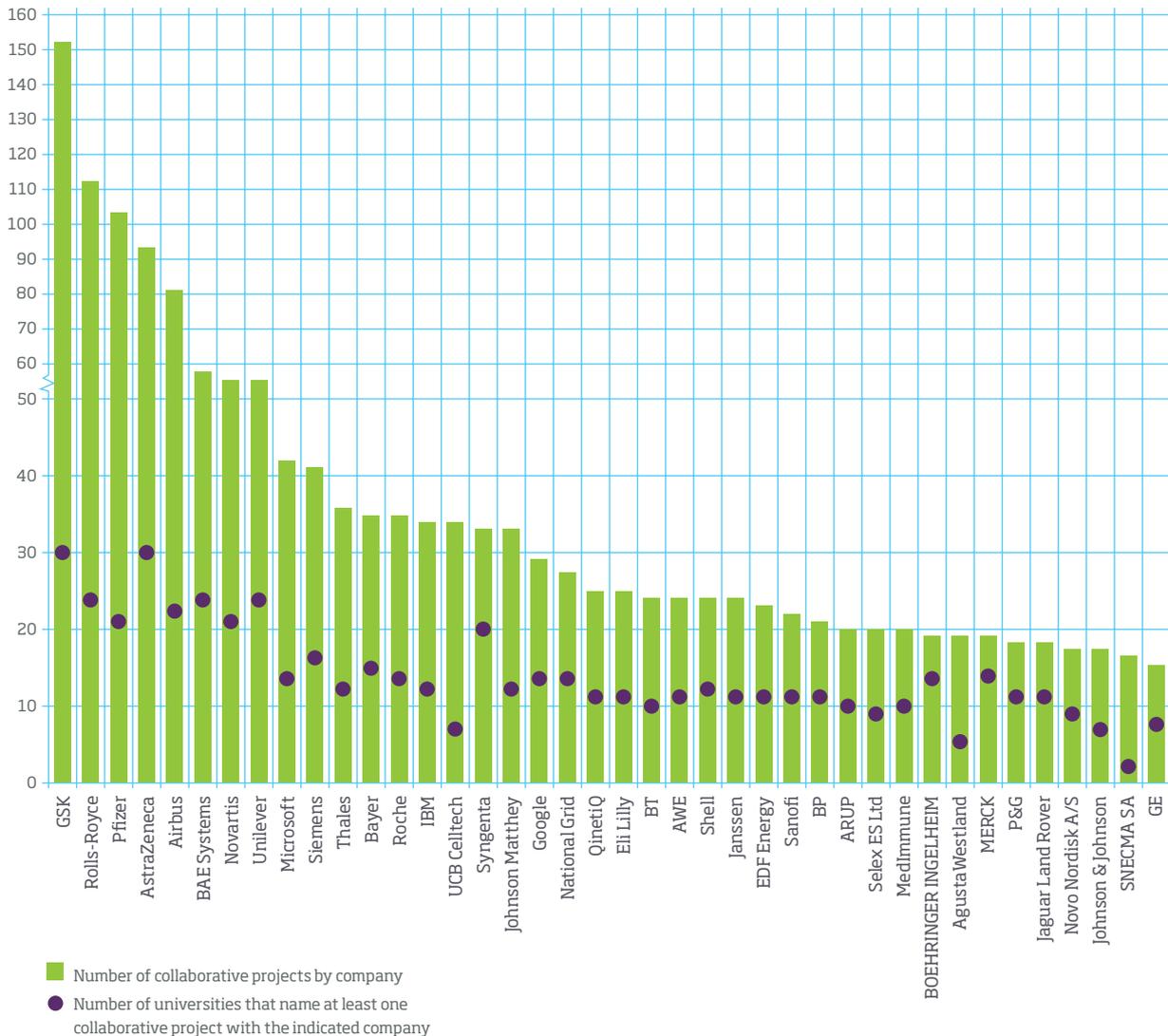
Figure 8
Collaborative projects by subject²²



23. Using the details provided by the universities about the department in which they were taking place, the collaborative projects were mapped against the disciplines covered by the REF panels. This analysis (Figure 8) shows the variability in the number of projects taking place across subject areas. Consistent with the REF Impact case study analysis, the largest number of collaborative projects was associated with departments aligned to the Engineering and Physical Sciences panel.

²² Universities were asked to report on all current collaborative research projects with businesses, including the department in which the collaboration was taking place. 91 universities responded, of which 68 provided data in a form amenable to further analysis. 12,240 collaborative research projects were listed across these 68 universities. To understand the breadth of subjects in which collaborations were occurring, each collaborative project was allocated to a REF subject panel and then further divided into subject sub-categories. Of all the collaborative projects recorded, 10,933 could be categorised according to subject. The allocation was not mutually exclusive and some collaborations were allocated to more than one panel. The size of the segment and number beside the segment reflect the number of collaborations occurring within the departments associated with that subject. The number of universities in which these collaborative projects were taking place was also analysed and is represented by the colour of the segment.

Figure 9
Top 40 companies²³



24. The 40 companies which were named most frequently as project partners are shown in Figure 9. It is worth noting that a significant proportion of these companies is headquartered outside the UK, reinforcing the significance of the UK's research base for attracting inward investment. Detailed analysis was only carried out on companies that were cited in two or more collaborative projects but there was a long 'tail' of companies that were only cited in a single collaborative project. It is difficult to interpret the significance of this due to the limitations associated with the data, but it suggests that there are a large number of companies that collaborate in a relatively restricted way with universities. While there could be various reasons underpinning this, there may be an opportunity for at least some of these companies to scale up their collaborations to a more strategic level.

²³ Details of how the company name data was 'cleaned' can be found in a methodological note available on the [Dowling Review website](#). A total of 377 companies were found to have a collaborative project with more than one university. This graph shows the 40 companies involved in the greatest number of collaborative projects, as indicated by the green bars. The number of universities in which these company specific collaborative projects were taking place was also analysed and is represented by the dark circles.

25. Overall, the analysis presented in Figures 5 and 6, alongside the information from Vice-Chancellors, indicates that while some companies have been exceptionally active and effective in building productive research collaborations with universities, the coverage of sectors and companies, and the extent to which companies collaborate, is extremely patchy. If these companies could grow their collaborations, alongside the other companies that have already recognised the benefits of collaboration with the UK research base, the scale of such activity could be substantially increased, helping partners on both sides and the UK as a whole to gain a competitive edge. Of course, this assumes that a company would be able to identify suitable partners and support mechanisms, and that academics would welcome the opportunity to collaborate. These assumptions are explored in detail in the ensuing chapters.

The UK research and innovation system: a complex landscape

26. In considering how to enhance support for collaborative R&D, it is necessary to understand the current mechanisms for support and how these relate to the research and innovation system. However, a recurring theme in evidence to this review has been that this very process of understanding the support available, and the UK's research and innovation infrastructure in general, is enormously challenging, especially for businesses.
27. Two of the key players in the UK's research and innovation landscape are the Research Councils and Innovate UK:
- The Research Councils are an important source of support for strategic research partnerships between businesses and universities, especially for partnerships with a very long-term focus which are likely to include an element of fundamental research. Contributors to the review were generally very supportive of the work done by the Research Councils and there were many examples of successful collaborations funded by the Councils. There is also some evidence that public funding for R&D which is channelled through the Research Councils leads to higher social returns, in terms of impact on private sector productivity, than that carried out by government departments.²⁴
 - Innovate UK is the main vehicle through which the government provides incentives for business-led technology innovation. Encouraging business-university collaboration is a key part of helping to meet its ambition of accelerating economic growth through innovation and there was widespread support during the consultation for the role played by Innovate UK in enabling this.^{25 26 27}

Other key players are described in Box 2.

28. Figure 10 represents an attempt to depict the UK's national research and innovation landscape in summary view, with an explanation of some of the main government strategies or initiatives given in Box 2. Inevitably, this representation will be incomplete and subjective but it serves to illustrate the bewildering array of organisations, structures and schemes that contribute towards support for collaborative research and innovation activity. It is little surprise that so many contributors to this review expressed frustration and confusion at the complexity of the UK's research and innovation system.

²⁴ *Rates of return to investment in science and innovation: a report prepared for the Department for Business, Innovation and Skills*, Frontier Economics, 2014

²⁵ *Written evidence submitted by the Technology Strategy Board*, Innovate UK, 2014

²⁶ *Business-university collaboration*, House of Commons Business, Innovation and Skills Committee, 2014.

²⁷ *Innovate UK response to BIS select committee report*, Innovate UK, 2014

29. This complexity matters. Firstly, it is a significant barrier to engagement for a company with an interest in collaboration. The problem is magnified for small businesses that have extremely limited capacity to devote to understanding and navigating the system.
30. Secondly, from a government perspective, it is hard to be confident that interventions are well-targeted when the system is so complex. Ultimately, research and innovation are intimately connected and, although concepts like Technology Readiness Levels (TRLs) provide a convenient shorthand, the progression from research to innovation to commercial success at scale is very far from linear. Interventions need to take account of the iterative nature of innovation in order to be effective, but with such a complex set of instruments it is very difficult to take a systems view of the schemes on offer, to understand their collective effectiveness, or to identify gaps in provision.
31. The complexity is at least partly a reflection of the tendency to create new initiatives without giving sufficient consideration to how these complement or build on existing initiatives. Individually, the funding schemes and sources of support may be welcomed, but the compound effect may be less than the sum of its parts. Indeed, the very complexity, combined with the absence of clear metrics for success in some cases, makes it very hard for government to assess the aggregate benefits of its investments across the innovation ecosystem.
32. If there is no obvious way of reducing this complexity, without subjecting those trying to use the schemes to further change or confusion, government can improve the user experience of the innovation system by working to 'hide the wiring'. This means providing a user interface, accompanied by appropriate support, signposting and advice, which is simple and coherent enough to enable users to find relevant schemes or networks, without being exposed to the full level of complexity at play.
33. An overarching recommendation for this review is therefore as follows:
 - **R1. The UK's research and innovation support system has become excessively complex.** This complexity thwarts efforts to encourage more collaborative R&D and poses particular problems for smaller businesses. It also hinders government's ability to take a systems view of its support mechanisms for research and innovation. The Research Councils and Innovate UK must ensure that their schemes are as simple and accessible as possible. **Government and its funding agencies should seek to reduce complexity wherever possible, for example by consolidating schemes with similar aims. Where simplification is not possible, every effort should be made to 'hide the wiring' from businesses and academics seeking support. [Govt/RCs/IUK/FCs]**

Box 2. The Research and Innovation Ecosystem

Figure 10 gives an overview of the innovation ecosystem at a national level. This system is complex, with key players including national, devolved and local government, the university system, businesses and the third sector. Some of the key schemes operating in this sphere are explained below. A full explanation of the terms in Figure 10 can be found in the Glossary.

Government support for innovation

The industrial strategy was launched by the UK government in 2013. It outlines the long-term ambitions for the UK to create improved employment opportunities, and increase economic growth by government working in partnership with industry. Through investment the strategy provides support for priority technologies (originally referred to as the 'Eight Great') in which the UK has research expertise and business capability to become a world leader: big data, space, robotics and autonomous systems, synthetic biology, regenerative medicine, agri-science, materials and energy. In parallel, strategic partnerships with a range of specific industrial sectors are being developed: aerospace, agricultural technology,

automotive, construction, information technology, international education, life sciences, nuclear, offshore wind, oil and gas and professional and business services. Each has a sector council which has helped develop a sector specific strategy. By working together the companies involved are able to create new opportunities and remove barriers to growth in their sector through regulation, support and coordination. In addition the industrial strategy also seeks to support skills development, access to finance for businesses and development of UK supply chains.

Innovate UK

Innovate UK is the UK's innovation agency and in 2014/15 had a budget of £536 million. Its aim is to 'fund, support and connect innovative businesses to accelerate sustainable economic growth'. It is responsible for the network of Catapults and runs a range of programmes that support business innovation, from the '_connect' open innovation network to 'Collaborative R&D' funding aimed at solving specific technical or societal challenges.²⁸

Research Councils

The seven UK Research Councils invest around £3 billion annually in research across the full spectrum of academic disciplines, from the life sciences to the physical sciences and engineering, the social sciences, and the arts and humanities. They support collaborative research through a variety of mechanisms.

Funding Councils

The Funding Councils are the bodies responsible for funding higher education. In England, this function is carried out by the Higher Education Funding Council for England; in Northern Ireland by the Department for Employment and Learning (DELNI); in Scotland by the Scottish Funding Council (SFC); and in Wales by the Higher Education Funding Council for Wales (HEFCW).

In the 2015–16 academic year: the total HEFCE grant available is £3,971 million;²⁹ HEFCW will allocate £154 million in funding for universities;³⁰ the SFC will allocate £1,041 million to universities,³¹ and DELNI has a non-ring-fenced resource departmental expenditure limit for higher education, including teacher training, of £186.5 million.³²

Innovation Centres

Innovation Knowledge Centres are Research Council and Innovate UK-supported centres of excellence in specific technologies.

The Scottish Funding Council launched its Innovation Centre programme in 2012. The Centres 'aim to enhance innovation and entrepreneurship across Scotland's key economic sectors, create jobs and grow the economy'.³³

PSREs

Government also funds a range of Public Sector Research Establishments (PSREs), such as the Met Office and National Physical Laboratory, many of which work collaboratively with businesses and universities.³⁴

Others

The National Centre for Universities and Business (NCUB) is an independent and not-for-profit membership organisation that was created to promote, develop and support university-business collaboration across the UK.³⁵

Local support

Local Enterprise Partnerships are partnerships between local authorities and businesses that decide on priorities for investment in an area. They are also mandated to promote local innovation.

University Enterprise Zones (UEZs) are 'specific geographical areas where universities and business work together to increase local growth and innovation' through a partnership of LEPs, universities and others, alongside a package of business support from government.³⁶ A pilot of four UEZs is currently underway.

²⁸ *Collaborative research and development funding*, Innovate UK, accessed June 2015

²⁹ HEFCE funding allocations website: <http://www.hefce.ac.uk/funding/annalocns/1516/>

³⁰ *Press release: Funding for Higher Education in 2015/16*, HEFCW, 2015

³¹ *Outcome agreements for universities*, SFC, 2015

³² *Budget 2015–16*, Northern Ireland Executive, 2015

³³ *Innovation Centres*, *Scottish Funding Council*, accessed June 2015

³⁴ *Letter from Sir Mark Walport*, House of Commons Science and Technology Committee, 2013

³⁵ About the National Centre for Universities and Business, <http://www.ncub.co.uk/who-we-are.html>

³⁶ *University Enterprise Zones*, www.gov.uk

2. Creating the conditions for successful collaboration

What makes a successful collaboration?

34. Contributors to the review were invited to identify the main success factors for, and barriers to, collaborations; the results are summarised in Figure 11 and Figure 12.
35. The key success factors outlined in Figure 11 emphasise the importance of strong and trusting personal relationships between partners in a collaboration, based on mutual understanding and a shared vision for what the collaboration could achieve. People are therefore central to making any collaboration work.
36. Figure 12 demonstrates that while there is a degree of commonality in the barriers encountered, business and academia operate in spheres with distinct financial and cultural pressures, which influence attitudes towards collaboration. It also reinforces the findings of previous reviews, which have noted the difficulties relating to securing effective agreements on IP and funding for collaborative research.^{38 39} These subjects are explored further later in this report.
37. Factors relating to the academic environment make up four of the top ten barriers to academics getting involved in collaborations (Figure 12), and many contributors to the review argued that successful collaborations tended to be developed under the initiative of individuals who were able to surmount the less than conducive institutional environment.⁴⁰ The pressure to win peer-reviewed research grants from public bodies, publish high impact papers, deliver high quality courses for students and continue with research all compete for the time and resources required for collaborations. These constraints are strong enough to be apparent to businesses, which report that the range of pressures on academic time, or the need to get the next grant, serve as barriers to collaboration. Without some slack in the system and a change in the incentive structures, academics are unlikely to be able to devote the resources necessary to identify, initiate and progress collaborative projects.
38. The lack of availability of funding and the difficulty in identifying and accessing the available government support was identified by businesses and universities as a barrier to collaboration. In addition, much of the evidence submitted argued that the best way to increase the amount of collaborative R&D undertaken by business in the UK was to stimulate overall business R&D investment levels. Measures that could help to address this are discussed in chapter four.

³⁸ *Best of both worlds: guide to business-university collaboration*, CBI, 2015; *Bridging the Valley of Death: improving the commercialisation of research*, House of Commons Science and Technology Committee, 2013; *Lambert Review of Business-University Collaboration*, 'The Lambert Review', 2003

³⁹ *Business-university collaboration*, House of Commons Business, Innovation and Skills Committee, 2014.

⁴⁰ This environment is shaped by a range of factors, discussed elsewhere in this Review, including: the metrics by which academic success is judged via the REF, the manner in which career progression is supported, the time required to deliver teaching commitments and the relative absence of time for other activities, such as collaboration or networking.

Figure 11
Top ten key success factors for a successful collaboration⁴¹



Figure 12
Top ten most highly cited barriers to collaboration⁴²



⁴¹ The call for written evidence included a question which asked respondents “What are the key success factors for building productive, long-term research partnerships between business and academia?”. Responses to this question were considered through a thematic analysis, and then ranked according to the frequency with which they were mentioned, to produce a “top ten key success factors”.

⁴² Written submissions to the review were assessed to find the most highly cited barriers to collaboration through a thematic analysis. Each submission was reviewed and the barriers to collaboration considered therein noted, alongside whether these barriers applied to universities or businesses. These barriers were then ranked according to the frequency with which they were cited.

People, relationships and trust

39. One of the most consistent messages to emerge from the consultation meetings was that strong personal relationships were found at the heart of any successful collaboration. This was also reflected in written submissions, where 'strong and trusting personal relationships' was the most frequently cited key success factor (Figure 11). Building trusting relationships that enable the collaborating partners to have an open dialogue over a period of months, or years, provides an essential foundation for a partnership. Without this, it is unrealistic to expect a company to share their long-term vision with the academics in the collaboration and, if this does not happen, it is quite likely that the academics will fail to address the research challenges that really matter to the company.
40. Investing in relationships from the outset also helps to ensure that there is good alignment of expectations and an appreciation of the motivations and challenges on either side. As discussed in chapter three, it is not uncommon for collaborations to be thrown off course by wrangles over contracts and IP and there is a much higher chance of such disputes being resolved amicably if there are key individuals in both parties who have a strong relationship, trust each other and are committed to seeing the collaboration succeed.
41. Many examples were provided during the review of large-scale collaborations that had grown organically from personal relationships at a relatively junior level. However, it was also noted that partnerships tend to be fragile if they revolve around one or two individuals who may then move on from their roles. Resilience can be achieved by ensuring that there are strong personal contacts between people who have the appropriate skills across multiple tiers in both organisations, involving effective working-level contacts, buy-in at senior level and a critical mass of people engaged in the collaboration. This topic is addressed in more detail in chapter three.
42. It is clearly difficult to make policy recommendations that will directly impact on the success of individual relationships, but the policies of the government and its agencies, and the collaborating organisations, can certainly influence the attractiveness of collaborative activities to individuals. Indeed, much of the evidence received highlighted the importance of aligning incentives across the research and innovation system to stimulate behaviours that promote collaboration.

Incentives for academics

43. There is a strong sense that, despite progress made, the academic environment does not yet sufficiently support, incentivise or reward collaborative work with businesses. One of the most powerful incentive mechanisms is the method of university research assessment, which also shapes the factors which help determine academic career progression. For many academics, the REF – run by the higher education funding bodies in England, Scotland, Wales and Northern Ireland – looms large.⁴³ With REF2014 results informing the allocation of research funding via higher education funding bodies from 2015–16, and establishing 'reputational yardsticks' for universities, its influence on universities has been (and continues to be) substantial.⁴⁴

⁴³ HEFCE, SFC, HEFCW, DELNI <http://www.ref.ac.uk/about/>

⁴⁴ <http://www.ref.ac.uk/about/>

44. For the first time, the REF2014 assessment included a consideration of the 'Impact' of research, using case studies to assess the quality and impact of UK universities' research in all disciplines. The inclusion of Impact has been broadly welcomed as a means of stimulating universities to articulate and ultimately improve the translation of their research into social, environmental or economic benefits (see Box 3). Working with business provides an important mechanism for achieving Impact and there are already indications that its assessment has catalysed a shift in the attention given by universities and academics to this aspect of their work. This in turn appears to be changing the way in which university-business collaborations are viewed and valued – a message that came through strongly in evidence to this review.⁴⁵ Impact would therefore appear to be a useful tool in encouraging further collaborative work.
45. It is to be expected that this first experience of assessing Impact will yield valuable lessons to inform future assessment exercises. In particular, it would be appropriate to consider whether the constraints on the qualifying conditions for case studies imposed in REF2014 were appropriate. There would also be merit in considering the interpretation of Impact across the panels: contributors to the review suggested that some sub-panels did not consider effects on business to be as important as those on policy. While this is anecdotal, it seems to be reflected in the sub-panel membership; some disciplines had minimal business user representation on either the sub-panels or amongst the assessors, which could have influenced the extent to which collaboration with business was considered to be indicative of Impact.

Box 3: REF 2014

REF 2014 defined 'Impact' as:

'any effect on, change or benefit to the economy, society, culture, public policy or services, health, the environment or quality of life, beyond academia'.⁴⁶

154 UK HEIs submitted 6,975 impact case studies to REF 2014. These were reviewed by 36 expert panels, consisting of 898 academic members and 259 research users.⁴⁷

An Impact case study is a short four-page document which has five sections:⁴⁸

1. Summary of the Impact
2. A description of the underpinning research
3. References to the research
4. Details of the Impact, and
5. Sources to corroborate the Impact

Each case study is assessed by using two criteria:

1. Reach- 'the spread or breadth of influence of effect on the relevant constituencies' and
2. Significance – 'the intensity of the influence or effect'.

44% of Impacts were awarded the top outstanding (4*) rating, with a further 40% considered to be 'very considerable' (3*).⁴⁹

The assessment of Impact accounted for 20% of REF 2014.⁵⁰ The remainder comprised 65% for 'Outputs' which assessed the 'originality, significance and rigour' of research outputs, primarily in the form of publications, and 15% for 'Environment' which assessed the 'vitality and sustainability' of the research environment.

⁴⁵ For example: *PraxisUnico submission to the Dowling Review*, PraxisUnico, 2015

⁴⁶ ⁴⁷ ⁴⁸ *REF 2014 Key facts*, www.ref.ac.uk, 2015

⁴⁹ *The nature, scale and beneficiaries of research impact: an initial analysis of Research Excellence Framework (REF) 2014 impact case studies*, King's College London and Digital Science, 2015

⁵⁰ Impact was originally intended to account for 25% of REF, but as Impact assessment in the 2014 REF was still under development the weighting was reduced to 20% <http://www.ref.ac.uk/pubs/2011-01/>

46. Beyond the REF, and despite widespread acknowledgement of the benefits of engaging in collaborative research projects, there is a strong feeling amongst members of the academic community that collaborative research is not valued as part of an academic career within universities. Instead, career progression is considered to rely heavily on the quality of the academic's publication record and their ability to win grant funding from competitive, peer-reviewed public sources. Universities need to ensure that their recruitment policies and promotion criteria recognise and reward successful commercial research collaborations as an integral part of research success in relevant disciplines.⁵¹ If this is already the case, it does not appear that the message is filtering through to researchers. This, in turn, affects attitudes towards movement between business and academia. The significance attached to REF scores and publication records also acts as a barrier for businesspeople seeking to move into academia.
47. Another factor that can discourage academics from pursuing collaborations is concern that accepting industrial funding for research may make the researcher vulnerable to accusations of conflicts of interest, especially if there is media interest in the story. Recent examples include criticisms of public health experts in receipt of funding from the sugar industry and of scientists involved in research to assess the benefits of drugs such as statins and antivirals, despite such research often being conducted at arms' length from industry funders.⁵² ⁵³ ⁵⁴ Universities need to make sure that they have robust and transparent conflict of interest policies and that these are marshalled effectively to deflect personal criticism of individual researchers. There may also be a need for the research community to engage more proactively with the media to address misconceptions about the consequences of industry funding.
- **R2. The evidence so far is that the inclusion of Impact in the REF has helped to stimulate a more positive attitude amongst academics towards collaboration with business. Successor exercises to the REF 2014 should:**
 - a **Maintain or increase the weighting given to Impact.**
 - b **Provide more explicit recognition for staff who have moved between industry and academia in either direction, or 'discipline-hopped',** for example by applying similar allowances to those made for researchers who have taken parental leave, applying a quality filter (e.g. the award of a competitive Fellowship to support the secondment) to minimise the risk of 'game-playing'. This provision could also be applied to researchers who have undertaken significant roles in funding agencies or government. It also needs to be communicated effectively to academics and university staff to encourage people to fully utilise the provision.
 - c **Consider universities' industrial collaborations, including the exchange of people and the success of their translation activities, as an important part of the 'Environment' component. [FCs]**
 - **R3. The perception that collaborating with industry, or spending time in industry, is damaging to an academic career path persists and detracts from the attractiveness of such activities for academics. Universities need to ensure that recruitment and promotion criteria for relevant disciplines reward rather than penalise academics who have achieved excellence in translational and collaborative activities, and that these messages are communicated effectively. [Univs]**

⁵¹ For example: *Consultation by Dame Ann Dowling on business-university collaboration*, Academy of Medical Sciences, 2015

⁵² For example: *Sugar: spinning a web of influence*, The BMJ, 2015

⁵³ For example: *Statins row: critics are biased, says doctor who warned of drugs' side effects*, The Independent, 2015

⁵⁴ For example: *Millions of patients given flu drugs with little or no benefit, study finds*, The Guardian, 2014

- **R4. Universities must be robust in the promotion and implementation of their institutional conflict of interest policies to help protect individual researchers who receive funding from industry against personal criticisms based on misconceptions about the role of industry in this research. The wider research community, including the Research Councils and Innovate UK, needs to be more proactive in engaging with the media to discuss the significance of industry funding for academic research. [Univs/RCs/IUK]**

Incentives for businesses

48. As discussed above, there is a wide range of potential benefits for businesses from collaborating with universities on research projects. Long-term, strategic partnerships offer specific benefits to companies, including the opportunity to achieve revolutionary rather than evolutionary technology developments. Moreover, when academics and businesses work together over many years, it becomes possible for the academics to truly understand the needs of the business and to identify new avenues for collaboration and opportunities for research to support the business, beyond those that the business itself may have recognised as being relevant.
49. Despite these benefits, the tendency for businesses to focus on the short-term, to the detriment of long-term R&D efforts, and the overall low levels of investment in R&D are both cited as key barriers for business seeking to engage in collaborations (Figure 12). It is understandable that businesses, especially SMEs, focus on managing the immediate pressures of day-to-day operations. Yet it is vital for the overall health of the UK economy that we create a business environment which encourages private-sector investment in R&D and innovation.
50. A number of reviews have noted that the UK lags behind competitor nations in terms of business investment in R&D.⁵⁵ For example, in its International Benchmarking analysis, the Department for Business, Innovation and Skills observed that the UK's general lack of R&D expenditure reflects relatively low spending in both the public and private sectors on R&D, and that this was due, in part, to the UK having fewer firms in sectors which might be considered research-intensive.⁵⁶ Although private-sector spending on innovation is higher, it does not in itself offset low spending on R&D.⁵⁷ To remain internationally competitive, the UK needs to both maintain its capacity to innovate and ensure that this innovation is translated to economic gain.⁵⁸
51. Universities Scotland has already drawn up a five point plan to further enhance university-business engagement, in support of Scotland CAN DO, the Scottish Government's entrepreneurship and innovation framework.⁵⁹ Point four of the plan, 'Raising awareness of the opportunities for business arising from university knowledge', addresses the need to increase demand for innovation from companies in Scotland, including research undertaken in collaboration with universities. The Scottish Government is also considering how to help entrepreneurs and innovative businesses to network with senior business leaders who have experience in this field, with the aim of facilitating mentoring as a way of supporting potential innovators.⁶⁰ The plan is in the early stages of implementation, but it will be important for the UK government to monitor its progress and take the opportunity to learn from the initiative.

⁵⁵ For example: *The UK's Innovation Deficit & How to Repair it*, University of Sheffield Political Economy Research Institute, 2013, p2; *Research and development*, House of Commons Library, 2014; *Policy briefing: Science and Engineering Investment*, Campaign for Science and Engineering, 2015; *Business-university collaboration*, House of Commons Business, Innovation and Skills Committee, 2014.

⁵⁶ *Insights from international benchmarking of the UK science and innovation system*, Department for Business, Innovation and Skills, 2014, p32

⁵⁷ *Insights from international benchmarking of the UK science and innovation system*, Department for Business, Innovation and Skills, 2014, p36

⁵⁸ *Insights from international benchmarking of the UK science and innovation system*, Department for Business, Innovation and Skills, 2014, p38

⁵⁹ ⁶⁰ *Scotland CAN DO*, Scottish Government, 2013

52. While medium-sized businesses make up a lower proportion of the UK's business population than in comparable countries, they also tend to be the most innovative in terms of revenues generated from new products or services.⁶¹ Several contributors to the review highlighted this category as being a particularly attractive target group for engaging in university collaboration since they tended to be focussed on growth and had a higher capacity to engage than small companies. Interventions aimed at SMEs are in fact targeted at a very heterogeneous group, with the needs of a medium-sized company being markedly different from those of a micro-company. Innovate UK needs to consider this in the shaping and promotion of its schemes. In addition, the 'cliff-edge' for companies that grow beyond the SME category could be better managed – at present it risks acting as a disincentive for growth. HEFCE has also recently produced a useful resource that profiles SMEs across England that could help HEIs identify the characteristics of their local SMEs.⁶²
53. There also seems to be a perception that the cost to business of carrying out collaborative research tends to be higher in the UK than elsewhere. This is difficult to measure accurately and there is very little objective data to draw on. As part of this review, a small number of companies provided, on a confidential basis, internal data about the costs of collaborating with universities in the UK and overseas. This confirmed the view that, for these companies at least, the cost of collaborating with UK universities was amongst the highest of the countries they worked in. However, it also revealed that companies who were able to make effective use of the various funding schemes and tax incentives available in the UK found that these could substantially reduce the costs of collaboration and thus increase the competitiveness of the UK as a location for collaborative R&D. This reinforces the importance of making sure that government funding mechanisms are simple, transparent and accessible to business. Importantly, these companies – as well as many others who contributed to the review – were clear that the costs of working with UK universities were a reflection of the high quality on offer and that this was often the key factor in determining the location of collaboration partners.
- **R5. There is an ongoing challenge to engage those companies that have never participated in collaborations but could profit from doing so. A campaign raising awareness of the benefits that companies have derived from university collaboration could play a helpful role in stimulating a broader base of demand.** Prior to roll out, the government should make use of well-designed field studies to test the effectiveness of such messages. [Govt/IUK]
 - **R6. Innovate UK, collaborating with others as appropriate, should develop a system of peer-to-peer advice for business leaders seeking to get involved in collaborative research or innovation for the first time.** [IUK]
54. Recommendations to encourage business investment in R&D are discussed in chapter four.

⁶¹ *Insights from international benchmarking of the UK science and innovation system*, Department for Business, Innovation and Skills, 2014.

⁶² *Collaboration between SMEs and universities – local population, growth and innovation metrics*, report to HEFCE by the Enterprise Research Centres (ERC), 2015

Promoting mobility

55. As discussed above, strong, trust-based relationships are at the heart of successful collaboration. At the system level, one of the most effective ways of catalysing the formation of these relationships and promoting mutual understanding between academia and industry is to increase the permeability of the interface, and the flow of people, between these two domains. Anecdotal evidence suggests the UK lags behind countries such as Germany and the US in this respect and many contributors identified this as a weakness of the UK environment for collaboration.
56. There are a number of schemes that exist to promote mobility between business and academia, such as those listed in Box 4 and Figure 10. However, the scale of these activities is insufficient to trigger the cultural change that is required, especially at more senior levels, and there are relatively few of these schemes which are driven by industry. The apparent lack of take-up of some of these schemes is perhaps not surprising in light of the misalignment of incentive and reward structures for individual researchers, including those resulting from the REF, as discussed previously. However, boosting mobility between industry and academia could yield substantial dividends for the UK.

Box 4: Promoting Mobility between Industry and Academia

There are a range of approaches being adopted to promote movement of personnel between universities and businesses. For example:

- Higher Education Innovation Funding and Impact Acceleration Accounts have been used by universities to fund secondments between businesses and academia.
- There are a number of visiting professorships across UK universities. For example, the LSE's Visiting Professors of Practice scheme allows individuals with expertise in their fields, without an academic background, to take up professorships at the university.⁶³
- The Royal Academy of Engineering funds an industrial secondment scheme to enable researchers to spend time in industry, and visiting teaching fellow and professor schemes to enable industry staff to spend time in academia.⁶⁴ It also co-funds Research Chairs with industry.
- The Royal Society's Industry Fellowship scheme supports the mobility of scientists working on collaborative research projects, allowing academic researchers to spend time in industry and vice versa.⁶⁵
- The Academy of Medical Sciences operates a mentoring scheme for clinical fellows seconded to GSK's R&D sites, to encourage engagement between the sectors.⁶⁶
- Research Council awards have been used to support secondments in specific research areas or institutions, for example the MRC's Proximity to Discovery Fund at Manchester University.⁶⁷

Industry may also fund secondments as part of collaborative projects. For example:

- A collaborative project between AstraZeneca and the University of Glasgow has established the 'GLAZgo Discovery Unit' within the University's Institution of Infection, Immunity and Inflammation.⁶⁸ Investment through the unit will support ten staff and PhD students, in addition to two way secondments between the university and AstraZeneca which aim "to facilitate the exchange of expert knowledge and skills".⁶⁹

⁶³ *LSE visiting staff schemes*, information from: <http://www.lse.ac.uk/europeanInstitute/staff/visitingStaff/visitingStaffScheme.aspx>

⁶⁴ *Royal Academy of Engineering: exchanges between industry and academia*, information from: <http://www.raeng.org.uk/grants-and-prizes/schemes-for-people-in-industry>

⁶⁵ *Royal Society Industry Fellowship*, information from: <https://royalsociety.org/grants/schemes/industry-fellowship/>

⁶⁶ *Academy of Medical Sciences mentoring scheme*, information from: <http://www.acmedsci.ac.uk/careers/mentoring-and-careers/mentoring/>

⁶⁷ *Medical Research Council Proximity to Discovery Industry Engagement Fund*, University of Manchester, information from: <http://www.manchester.ac.uk/collaborate/business-engagement/knowledge-exchange/collaboration-funding/mrc-p2d/>

⁶⁸ *GLAZgo Discovery Centre*, information from: <http://www.ncub.co.uk/success-stories/glazgo.html>

⁶⁹ GLAZgo Discovery Centre website: <http://www.glazgodiscoverycentre.co.uk/aboutus/thecentre/>

- BP and the University of Cambridge established the BP Institute for Multiphase Flow in 2000, via an endowment of approximately £22m from BP to fund the building, research staff and ongoing support.⁷⁰ Within this Institute, BP supports a programme of visiting fellowships, whereby academics at the Institute can spend approximately 20 per cent of their time at BP's offices. This helps establish connections between academics and BP staff, builds business engagement skills, and can highlight areas of the business which could make use of novel technologies/technologies under development.⁷¹

57. There are of course flows of people between academia and industry that are not mediated by funding schemes. In this regard, students were identified by contributors to the review as having a pivotal role to play. Numerous research collaborations have their roots in relationships between a company and a university that have arisen through recruitment of graduates and/or postgraduate researchers. Many universities said that one of the main reasons companies were keen to enter into collaborations of any type was to gain access to their student talent pool. Furthermore, undergraduate projects carried out during a sandwich course placement, university holiday, or as a final year project were seen as having the potential to provide the short-term interactions which set in place relationships that could grow into research collaborations at a later date.
58. Students – both undergraduate and doctoral – are also an important target group in terms of stimulating cultural change within the research community. Ensuring that students in appropriate subjects gain industrial experience and receive basic skills training in topics of relevance to business and entrepreneurial activity at the outset of their career should make a long-term contribution to improving mutual understanding between the business and academic communities, and the ease with which people can move between these. There are already some examples of good practice in helping students or early career researchers acquire business experience or develop business-relevant skills. For example, EngDs include time in industry as an integral part of doctoral training and consortia supported by the Arts and Humanities Research Council have facilitated PhD student placements in creative businesses.
59. People who can work in both business and academia and who excel at collaborative and translational activities need to be valued and recognised. Being able to cross this divide requires skill and builds expertise and experience. For an academic, gaining experience in industry should be considered career enriching and a mark of distinction, analogous to gaining international experience. For relevant disciplines, every newly appointed Principal Investigator (PI) should be expected to secure some business experience, even if only for a few months, if they do not already have it.
60. There would also be significant benefit to be gained from giving greater exposure to the stories of those researchers whose career success has been enhanced by movement between industry and academia. Promoting these role models could make an important contribution to breaking down the false distinction between excellence and relevance that is sometimes made in academia.
- **R7.** Greater awareness of role models whose career progression has been helped by spending time in and/or working with business should inspire and encourage others to consider a similar path. **Funding bodies and universities should do more to promote examples of researchers who have derived particular benefit from collaborating with industry. [FCs/RCs/IUK/Univs]**

⁷⁰ BP Institute website: <http://www.cam.ac.uk/research/news/bp-institute-for-multiphase-flow>

⁷¹ *Lessons from practice*, University of Cambridge IAA best practice, information from: <http://www.admin.cam.ac.uk/offices/rso/iaa/bestpractice/secondment-lessons-from-practice-140426.pdf>

- **R8. For academics in relevant disciplines, spending time in industry should be seen as a mark of esteem that enriches their career, analogous to gaining international experience. Universities and research institutions should expect newly appointed Principal Investigators in such disciplines to gain industrial experience (if they do not already have any), and funding agencies should ensure that grant conditions encourage this. [Univs/RCs]**
- **R9. Forming connections with business at the outset of an academic career path could significantly enhance the environment for collaboration over the longer-term. To enhance doctoral training:**
 - a **Universities should ensure that all PhD students in appropriate subjects receive IP awareness and wider business skills training.**
 - b **The Research Councils and other major funders of PhD studentships should support students in appropriate subjects to spend some time in business as part of their doctoral training.**
 - c **Universities should play an active role in facilitating industrial placements for their PhD students, and should advertise the fact that they do this to potential students. [RCs/Univs]**

Catalysing connections

61. As discussed in chapter 1 and illustrated in Figure 10, the innovation landscape is incredibly complex. A business looking to get involved in collaborative research may have to navigate a range of networks, funding agencies and institutions in order to get a project off the ground. As a first step, even finding a partner can be difficult, especially for SMEs, which do not have spare capacity to spend time searching for where university expertise is located and for whom the geographic proximity of potential partners might be especially important. Finding the right person was identified as a key barrier to collaboration by contributors (Figure 12), and there is strong demand for tools to help make this easier.
62. The challenge of finding a university with relevant skills and knowledge to match a particular business need has been noted in previous reviews.⁷² Different approaches to addressing this challenge have already been initiated or implemented, for example:
- The Knowledge Transfer Network (KTN) is a staffed intermediary organisation established by Innovate UK. It is primarily business facing and aims to connect people to speed up innovation.⁷³
 - _connect is an 'online open innovation network of networks' set up by Innovate UK.⁷⁴
 - Following the Witty Review, universities have made progress in offering single points of access to provide a way in for SMEs seeking to collaborate.⁷⁵
 - The Research Councils' Gateway to Research offers a searchable online database of publicly-funded research.⁷⁶
 - The Council for Science and Technology science landscape project is aiming to 'build a picture of the whole research landscape in the UK' by collecting inputs from researchers.⁷⁷

⁷² See, for example: *Business-university collaboration*, House of Commons Business, Innovation and Skills Committee, 2014; *State of the Relationship 2015*, NCUB, 2015; *Government response to the Business, Innovation and Skills Committee report on Business-university collaboration*, Department for Business, Innovation and Skills, 2015.

⁷³ KTN website: <http://www.ktn-uk.co.uk/>

⁷⁴ _connect website: <https://connect.innovateuk.org/home>

⁷⁵ *Encouraging a British Invention Revolution: Sir Andrew Witty's Review of Universities and Growth*, 'The Witty Review', 2013, p40

⁷⁶ Gateway to Research website: <http://gtr.rcuk.ac.uk/resources/about.html>

⁷⁷ UK Knowledge Landscape website: <https://www.ukknowledgelandscape.co.uk/welcome>

- In 2005 Interface was established in Scotland to connect businesses to Scotland's higher education and research institutes.⁷⁸
- In 2007 the Department for Employment and Learning Northern Ireland launched the 'Connected' programme – an initiative bringing together both universities and the six further education colleges to provide a 'one-stop-shop' for companies wishing to access the technology and knowledge capital within the local research base.⁷⁹
- The Open Platform for Innovative SMEs (OPENISME) is in the early stages of development and aims to improve the connectivity between SMEs and European research.⁸⁰
- The Scottish EU funding portal is a newly created online resource for organisations and businesses interested in EU funding and transnational project collaboration.⁸¹
- The Enterprise Europe Network (EEN) is the official European Commission business support network, with over 600 member organisations, which aims to assist European SMEs that want to grow.⁸² There are 11 EEN consortia in the UK, managed by Innovate UK.
- There are also private providers of brokerage services.

63. Despite the multitude of initiatives, the frequency with which the need for an online brokerage service is highlighted by business indicates that for many users a solution to the problem is not yet available. Better support is needed both to help businesses – especially SMEs – find academics working in the field in which they are interested and to guide them through the process of establishing a partnership.

Online brokerage tool

64. HEFCE, Innovate UK and the Research Councils are currently working together with NCUB to develop an 'Intelligent Brokerage Tool' for the UK. This project aims to create an online resource that will help business to identify potential research partners, facilities and sources of support for a collaborative project. NCUB states that this tool will draw from websites such as Gateway to Research, _connect and equipment.data.ac.uk, creating a service which amalgamates and enhances these functions.⁸³
65. The case for developing better brokerage tools is irrefutable. However, there is a question over whether the development of this (or any) new tool is likely to be able to deliver the anticipated value to users, especially in a policy area that seems to be subject to near constant change. Larger businesses that are well acquainted with the UK research base already use a variety of public and commercially available services seemingly successfully, and it is unclear how the proposed brokerage platform will engage businesses that are new to collaboration.
66. While the Research Councils and Innovate UK are key sources of information regarding collaboration, many research partnerships are established directly between universities and businesses or are supported by other agencies, including international funding bodies. The canvassing of Vice-Chancellors undertaken within this review revealed a measure of the difficulty associated with trying to build up a full picture of collaboration across the UK. Developing a complete map of collaboration would, however, be

⁷⁸ Interface website: <http://www.interface-online.org.uk/about-us>

⁷⁹ Connected website: www.connected.ni.org

⁸⁰ About OPENISME: http://www.tages.biz/index.php?module=news&page=readmore&news_id=474

⁸¹ EU funding portal: <http://www.funding-portal.eu/>

⁸² EEN website: <http://een.ec.europa.eu/>

⁸³ *State of the Relationship 2015*, NCUB, 2015; *Government response to the Business, Innovation and Skills Committee report on Business-university collaboration*, Department for Business, Innovation and Skills, 2015.

extremely valuable – not least because exposing the relationships that do exist between companies and universities may well trigger corrective behaviour amongst organisations that do not currently participate to the same extent as their competitors and peers. It would therefore be desirable for the portal under development to include information on the complete collaboration landscape, beyond those partnerships which have been funded by the Research Councils and Innovate UK.

67. It is also important to note that businesses do not only require an online matching service, but an integrated package of support which can help them to identify potential partners and provide a guide through the maze of different agencies providing funding support. In addition, the outputs of such a service need to be accessible to non-specialist audiences. This type of functionality cannot be achieved solely through a database: it requires support from an appropriately skilled person. The value of such an approach is demonstrated by services such as the Interface system in Scotland.
- **R10.** There is a pressing need for greater support for businesses and academics seeking to identify potential partners for collaboration. **HEFCE, Innovate UK and the Research Councils are working with the National Centre for Universities and Business (NCUB) to develop an online brokerage platform. To be effective, brokerage services need to:**
 - a **Include data on business-university partnerships that are funded by industry, charities or international agencies, as well as public funders such as the Research Councils and Innovate UK.**
 - b **Provide information on potential sources of funding and support.**
 - c **Be accessible to a non-specialist audience**, including those with no knowledge of UK funding agencies or the jargon used to describe their activities.
 - d **Be complemented by access to well-informed personnel** who can guide SMEs through this complex and unfamiliar terrain.
 - e **Have a clear evaluation framework to enable assessment of whether the portal has achieved the objectives set.**
 - f **Be communicated pro-actively and energetically** so that SMEs in particular are aware of the support services that exist. Organisations that are already known to business, such as the KTN, have an important role to play here. **[FCs/ IUK/RCS]**

Physical spaces: Catapults, clusters and hubs

68. Collaboration is a contact sport, so shared physical spaces can be incredibly valuable for providing an environment to stimulate and support collaborations. Co-location of academics and industrialists can generate a vibrant environment that fosters knowledge creation and technology transfer, and collaborative work is often at its most effective when people are able to work side-by-side, with a free flow of ideas. Physical hubs can catalyse contacts between relevant individuals or organisations and provide a framework for collaboration. However, hubs are by no means a panacea and there is a litany of well-intentioned initiatives that have failed to engage users successfully. Physical hubs tend to support collaboration best when they provide an attractive and concrete service in addition to shared space. The services on offer have to match a need in the business or academic community in order to persuade people to use them. This can be brokerage, funding, access to specialist equipment or services, or simply common ground for experimentation.
69. Physical spaces for collaboration can take a variety of forms – Catapults, clusters and hubs included – in response to the requirements of the project, sector or local region. For example, in the creative industries, hubs have proved effective at supporting innovation

Box 5. Hubs and the creative industries

The UK creative economy employs over 2.5 million people.⁸⁴ Creative hubs play ‘an increasingly important role in how creative people and businesses interact, collaborate and socialise’.⁸⁵ Definitions of what constitutes a ‘hub’ vary, but they have been described as: ‘an infrastructure or venue that uses a part of its leasable or available space for networking, organisational and business development within the cultural and creative industries sectors’. A Creative Hub also demonstrates a mandate to:

- Provide support by way of services and/or facilities to the ideas, projects, organisations and businesses it hosts, whether on a long-term or short-term basis, including skills training, empowerment, capacity building, and global digital opportunities;
- Facilitate collaboration and networking among its users or members;
- Reach out to research and development centres, institutions, and creative and non-creative industries;
- Communicate and engage with a wider audience, developing an active communication strategy;
- Champion and celebrate emerging talents; exploring the boundaries of contemporary practice and taking risks towards innovation.⁸⁶

Perhaps unlike other hubs, creative hubs are often relatively independent in nature with the drivers for hub development coming from individuals rather than institutions. That said, there are a number of examples of hubs developed in partnership with HEIs. For example, the REACT Hub is a collaboration between the University of the West of England, Watershed and the Universities of Bath, Bristol, Cardiff and Exeter. It is a Knowledge Exchange Hub for the Creative Economy, funded by the Arts and Humanities Research Council, with the aim of working to ‘develop strategic partnerships with creative businesses and cultural organisations, to strengthen and diversify their collaborative research activities and increase the number of arts and humanities researchers actively engaged in research-based knowledge exchange’.⁸⁷

Hubs can bring people together by holding events, developing directories of local businesses, offering shared studio spaces, aggregating information resources, providing training and supporting networks.

NESTA has produced a seven-point guide for policymakers when seeking to develop creative clusters or hubs. These are:

- To build on areas of existing strength, rather than trying to create a cluster from scratch.
- To use business data, such as the number, size and growth trajectory of local firms, alongside university data, such as the types of graduates and research being produced in an area, in order to identify areas of local strength.
- To think systematically, taking into account local skills and research base, finance, competition regimes and infrastructure, rather than undertaking discrete interventions.
- To listen to all voices in the cluster.
- To raise visibility, or undertake ‘profile-raising’ activity, to highlight the opportunities available and help strengthen networks.
- To invest in people as well as buildings.
- To make sure universities are involved, taking advantage of their different functions in terms of suppliers of graduates, research, facilities or networks.⁸⁸

⁸⁴ *A manifesto for the creative economy*, NESTA, 2013

⁸⁵ British Council Creative Hubs website: <http://creativeeconomy.britishcouncil.org/projects/hubs>

⁸⁶ British Council creative hubs project: <http://creativehubs.org/en/creative-hubs-project/what-is-a-creative-hub>

⁸⁷ REACT website: <http://www.react-hub.org.uk/about/>

⁸⁸ *A manifesto for the creative economy*, NESTA, 2013, p61

in a range of ways (Box 5). The clustering and co-localisation of shared physical spaces can have an important role to play in the success of research and innovation in the local region in which they are situated; this is discussed further in chapter four. Businesses innovate more when their surrounding area is more innovative, as a result of knowledge spill overs and agglomeration effects, and strong local innovation systems nurture high technology clusters.⁸⁹

70. Examples of physical centres that serve as hubs for collaboration include Innovation Knowledge Centres and Public Sector Research Establishments:
- Innovation Knowledge Centres (IKCs) are Research Council and Innovate UK-funded centres of excellence in particular disruptive technologies. Seven IKCs have been funded since 2007 with the aim of accelerating and promoting exploitation of an emerging technology by business.⁹⁰ These centres are based in universities, where ‘their international quality research capability and access to companion technologies’ helps drive the commercialisation of research.⁹¹
 - Public Sector Research Establishments (PSREs) are publicly-funded bodies which carry out research in support of government policy-making or regulatory functions.⁹² These engage in a range of knowledge transfer activities, which include free dissemination of research outputs, contract research on behalf of industry, and support for spin-off companies, in addition to collaborative research projects.⁹³
71. A number of physical centres have also been created with support from the UK Research Partnership Investment Fund (UKRPIF), which is managed by HEFCE in collaboration with the other three UK higher education funding bodies. UKRPIF supports large-scale research facilities in HEIs that can also attract private investment. To date, HEFCE has allocated over £500 million to 34 projects running between 2014–17, attracting £1.3 billion of investment from business and charities.⁹⁴
72. The Catapults have been one of the most high profile developments in the innovation landscape in recent years and provide people and a physical and/or digital infrastructure to support late-stage research and development to take innovative ideas from concept to reality. Funding for each Catapult is generated, broadly equally, from business-funded R&D contracts, collaborative R&D projects which are funded jointly by the public and private sectors, and core public funding. Facilities and capabilities available in centres such as Catapults can help anchor investments in the UK by global organisations, while collaborative R&D, which constitutes a third of Catapult funding, was found to have a GVA return of £6.71 for each £1 of public investment, alongside a range of spillover effects.^{95 96 97} The evolution of such a network does not happen overnight, and Catapults are at a relatively early stage in their development, but the results so far have been promising, with positive feedback about the establishment of the Catapults widespread, as reflected in the recent review undertaken by Hermann Hauser KBE FREng FRS.⁹⁸

⁸⁹ *Our plan for growth: science and innovation evidence paper*, Department for Business, Innovation and Skills, 2014

⁹⁰ EPSRC website: <https://www.epsrc.ac.uk/newsevents/news/ikcsynbio/>

⁹¹ EPSRC website: <https://www.epsrc.ac.uk/innovation/business/opportunities/ikcs/>

⁹² These are funded by the Research Councils or directly by government departments. See, for example, *Sixth annual survey of Knowledge Transfer activities in Public Sector Research Establishments*, Technopolis, 2011.

⁹³ *7th Survey of Knowledge Transfer Activities in public Sector Research Establishments (PSREs) and Research Councils*, WECD, 2014.

⁹⁴ HEFCE website: <http://www.hefce.ac.uk/rsrch/ukrpif/>

⁹⁵ Oxford Economics (2008). ‘Study of the impact of the Intermediate Research and Technology Sector on the UK Economy’. Available at: <http://www.airto.co.uk/oxfordeconomics.pdf>

⁹⁶ Institute for Fiscal Studies (2006). ‘University Research and The Location Of Business R&D’. Available at: <http://www.ifs.org.uk/wps/wp0702.pdf>

⁹⁷ *Our plan for growth: science and innovation evidence paper*, Department for Business, Innovation and Skills, 2014, p25

⁹⁸ *Review of the Catapult network*, Dr Hermann Hauser, 2014

73. Each Catapult will develop differently, according to the needs of the sector in which it operates and the maturity of its activities. Some, such as the High Value Manufacturing Catapult, build on decades of investment in the centres that came together to form the Catapult. This provides a critical mass of infrastructure, co-location opportunities and trained staff, all of which are clearly of significant value for industry. Some other Catapults are new ventures and need to be given time to develop.
74. Comparisons are often drawn between the Catapults and Germany's Fraunhofer system, which has received sustained support for a period of over 60 years. There are many differences between both the Catapults and Fraunhofers and the environments in which they exist, but the need for stable, long-term support in order to reap the potential offered by this type of expertise and infrastructure is undoubtedly common to both systems. The core grant from government that provides one third of the Catapult funding model is essential for leveraging the project grants and business funding streams and for ensuring that the Catapults can build and maintain capability and infrastructure of the quality needed to provide effective support.
75. An emerging challenge is that the strong reputation that has built up around Catapults is leading to growing demand for the establishment of new Catapults, with a risk that areas of the country and sectors that lack direct access to Catapults will feel disenfranchised, and that opportunities to accelerate translational research will be lost. Hermann Hauser recommended that the network should be expanded to 20 Catapults by 2020 and 30 by 2030. Gradual growth in the number of Catapults would be desirable, providing that any expansion of the network is not at the expense of continued support for the existing Catapults. As noted above, critical mass is a key success factor for Catapults and the temptation to 'spread the jam thinly' must be avoided at all costs.
76. The creation of local centres by Catapults provides an opportunity to expand the geographical footprint and technology reach of the network. They also provide a new means of supporting business involvement in innovation at a local level, in line with the growing awareness of the role of innovation and local growth. For example, the Digital Catapult has created local centres in the North-East and Tees Valley, Brighton and Yorkshire. Each local centre is comprised of a consortium of universities, businesses and the Local Enterprise Partnership and seeks to capitalise on unique local strengths to bring benefit to the local area and provide an easy access point for SMEs.
77. The Catapults are now an integral part of the UK's innovation landscape, so it is important that they are appropriately linked with the other major players in the innovation system. Evidence to this review suggested that in some cases there is scope to strengthen the relationships between Catapults and universities. Catapults can help universities to build relationships with SMEs through their role as a hub, for example, and the R&D undertaken in Catapults can give rise to fundamental research questions which universities are well placed to address. As part of their Key Performance Indicators (KPIs) Catapults are already required to report on the number of academic institutions with which they are involved in formal collaborations. Given the significance of these relationships more sophisticated KPIs may be required to ensure interactions between Catapults and universities are reaching their full potential. A similar sentiment was expressed in the Hauser review of Catapults.⁹⁹

⁹⁹ *Review of the Catapult network*, Dr Hermann Hauser, 2014, p42

- **R11. The Catapult system is now an integral part of the UK's innovation landscape** and has broad support from across the academic and business communities. **To reap the benefits:**
 - a **The system needs to continue to receive long-term, sustained support from government** – while Catapults have achieved success in attracting industry and grant funding, block funding from government is a critical component of the model.
 - b **The metrics used by Innovate UK to evaluate Catapults' performance should include indicators that capture the success of their engagement with universities.**
 - c **Gradual growth in the number of Catapults would be beneficial, but any growth in Catapult numbers should only occur if additional funding is available and should not be at the expense of the support assigned to existing Catapults. [Govt/IUK]**
78. A significant disincentive to the creation of shared physical spaces is the levying of VAT on shared facilities. The construction of publicly-funded or charity research institutes is eligible for zero-rate VAT on account of it being considered a Relevant Charitable Purpose. Research institutes which are publicly funded can therefore opt not to pay VAT. If they do so, the amount of commercial activity on their premises cannot exceed 5%, and this 'commercial activity' includes research collaboration with industry. This means that 95% of activity on these sites must be for non-business research, or the whole facility will face a costly additional tax bill.
79. The way in which the VAT system operates therefore has serious consequences for the research institutions which are funded by the government, universities or charities, such as the Francis Crick Institute and even the Advanced Manufacturing Research Centre (part of the High-Value Manufacturing Catapult) which has an explicit remit to support industry. The VAT system forces them to choose whether to risk a hefty tax bill or lose the benefits of collaboration with business through co-location, and this choice gets built into the design of the institution. This is an area where government policies act at cross purposes: researchers from universities/public institutes are encouraged to collaborate with business, but the tax system imposes significant costs if this is done at any scale.
- **R12. The government needs to address the issue of VAT on shared facilities as a matter of urgency. [Govt]**

3. Making it happen

Seeding collaborations

80. The Research Councils and Innovate UK are major sources of funding for business-university collaboration in the UK. The Research Councils offer support for collaboration through a number of routes, including:
- *Brokerage and networking*, for example via the National Centre for Universities and Business and the Gateway to Research.
 - *Direct collaboration with industry*, for example through the formation of strategic partnerships, Research Industry Clubs and consortia.
 - *Support for collaborative projects* through, for example, Industrial Partnership Awards and Catalysts, which are co-funded with Innovate UK.
 - *Support for training*, for example CASE Studentships, Centres for Doctoral Training and supporting Knowledge Transfer Partnerships in conjunction with Innovate UK.
 - *Funding to universities for the translation of research*, for example via Impact Acceleration Accounts.
 - *Support for hubs and shared facilities*, for example Research and Innovation Campuses and Innovation Knowledge Centres.¹⁰⁰
81. Innovate UK supports research collaborations via a variety of funding routes, including its collaborative R&D funding programme, the jointly-funded Catalysts referred to below, Knowledge Transfer Partnerships and the Catapult network.
82. In general, Research Councils concentrate on funding excellent research at Technology Readiness Levels (TRLs) 1–3, while Innovate UK focuses on TRLs 4–6. Accepting the limitations of the TRL system for describing the highly iterative and interactive nature of innovation, there is a sense that greater alignment is needed in order to enable a more seamless transition between the funding agencies.
83. There are many good examples of Research Council and Innovate UK collaboration, particularly for jointly created calls, and the co-funded Catalysts in Agri-Tech, Energy, Industrial Biotechnology and Biomedical have been warmly welcomed. However, the increasing emphasis on Impact is encouraging universities to engage with innovation projects, often via collaborative research, which venture into higher TRL levels, and high-quality research with strong commercial potential can reach a ‘cliff-edge’ when it becomes ineligible for Research Council funding. While it cannot be expected that Innovate UK will always pick up the baton, there would be merit in making it easier for academics who have conducted promising research that is ready for development to higher TRLs to find industrial partners. Indeed, there was a degree of frustration on the part of academic contributors that they were not able to access readily the intelligence within Innovate UK that would help them to identify potential partners for collaboration, especially SMEs. More generally, closer communication and collaboration between the Research Councils and Innovate UK could further strengthen the offering for collaborative R&D and innovation support.

¹⁰⁰ *Written evidence from the Research Councils* to the Business, Innovation and Skills Committee, Research Councils, 2014

84. Another specific area for improvement identified in the consultation was in the timescales for calls issued by both Innovate UK and the Research Councils. In the case of the latter, a lack of advance notice of calls where industry might collaborate with universities was perceived as prohibiting participation by companies that could not secure internal sign-off before the call closed. Allowing businesses and universities an insight into the planned programme of calls for collaborative work could help to ensure that the highest quality partnerships, including newly formed ones, are represented amongst the proposals submitted.
- Mechanisms to support innovation need to straddle the research and innovation continuum. Greater coordination between the Research Councils and Innovate UK is required to ensure that this happens effectively. In addition to communicating effectively with each other, the Research Councils and Innovate UK need to ensure that they are communicating effectively with both universities and businesses. To help ensure this:
 - **R13. The Research Councils and Innovate UK should build in sufficient time in their advertisement of calls for proposals where industry may be a partner in order to ensure that all companies who wish to participate have reasonable opportunity to do so and there is time for new research partnerships between businesses and universities to be put together. [RCs/IUK]**

Knowledge Transfer Partnerships (KTPs)

85. The Knowledge Transfer Partnership (KTP) scheme is an Innovate UK-funded programme that facilitates the formation of a partnership between a company or not-for-profit organisation and an academic institution for the formulation and delivery of an innovative, collaborative project. To manage and deliver the project, recently qualified individuals are recruited as KTP Associates. The average annual cost of a project is around £60k,¹⁰¹ with SMEs contributing around a third of the project costs and large companies contributing around half.¹⁰² KTPs are particularly popular with SMEs: in 2013–14, 81% of KTPs involved SMEs. Projects can last between six months and three years.
86. KTPs are one of the most popular schemes for supporting business-university collaboration and have been shown to yield clear benefits for the parties involved. An analysis by Innovate UK found that 58% of KTP Associates were offered employment by their host company upon completion of the scheme and each KTP project typically resulted in an increase in annual exports of £967,000 and three new staff being employed (including the Associate).¹⁰³ Having gained this experience of working with a university, 86% of businesses reported that they had plans for further collaboration. As a result, return on investment in KTPs has been estimated at £4.70 to £5.20 of net additional Gross Value Added (GVA) per £1 of public funding.¹⁰⁴ KTPs therefore have a role in delivering economic returns and supporting skills development both for graduates and within companies.
87. KTPs are one of the longest-running schemes within the innovation ecosystem. That this scheme has continued for over 40 years is testament to its effectiveness and the ongoing demand for the support it provides. Although it is a valued mechanism for knowledge transfer, the availability of KTPs, as outlined in Figure 13, has decreased from a peak of 1050 classic KTP projects in 2010 to 664 in April 2013 due to funding restrictions implemented in the 2010 comprehensive spending review.¹⁰⁵ ¹⁰⁶ Complaints

¹⁰¹ ¹⁰⁴ *Knowledge Transfer Partnerships Strategic Review*, Regeneris Consulting, 2010

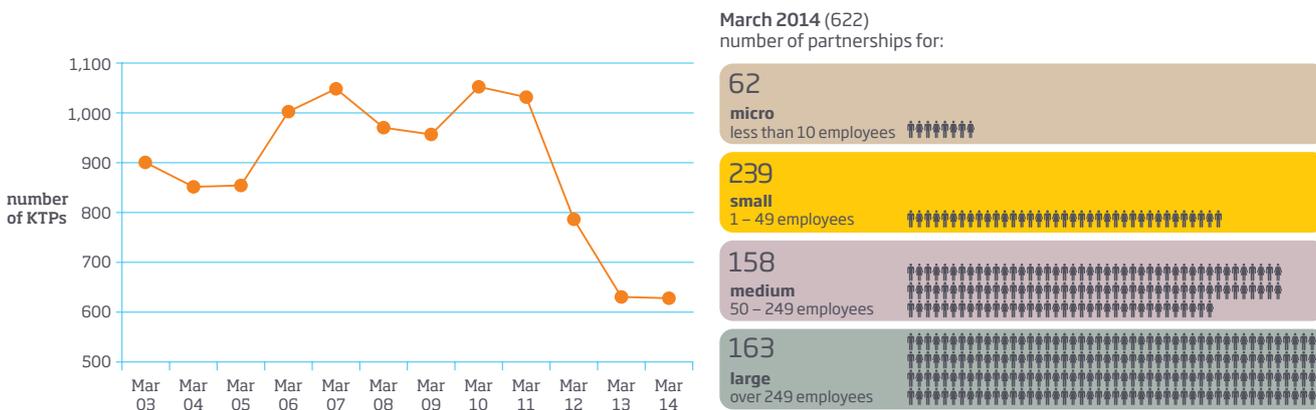
¹⁰² Innovate UK website: <https://www.gov.uk/innovation-get-details-about-innovate-uk-funding-competitions>

¹⁰³ *Knowledge Transfer Partnerships: achievements and outcomes 2013 to 2014*, Innovate UK, 2015

¹⁰⁵ Projects of more than one year in duration

¹⁰⁶ *Knowledge Transfer Partnerships Achievements and Outcomes 2010 to 2011*, Innovate UK, 2012

Figure 13
Number of KTPs and Business Size¹⁰⁷



were also heard in the course of this review regarding the bureaucracy, length of the proposal and time associated with applying for the scheme. Innovate UK has reviewed the scheme periodically to examine the scope for improvement, including in these areas. These reviews have concluded that the resource-intensive proposal development process plays a key role in the establishment of the collaborative team and of common expectations, both of which support effective knowledge transfer. However, concerns over the burden associated with applications remain and a further review is underway.¹⁰⁸ It is important that Innovate UK ensures that the application process for KTPs is proportionate to the size of the grant on offer.

- **R14. KTPs have proved to be highly valuable for facilitating knowledge transfer and seeding collaborations. Innovate UK should increase levels of KTP funding to enable it to better meet demand for the scheme, as well as ensuring that the burden on applicants is proportionate to the size of the grant. [IUK]**

CASE studentships

88. CASE studentships (formally known as Collaborative Awards in Science and Engineering) provide another mechanism to enable businesses and universities to embark on collaborative working and can act as a precursor to more substantial relationships, if mutual benefit is found. They take the form of jointly funded collaborative awards for PhD students co-sponsored by the Research Councils and a partner from business, the public sector or third sector. Such collaborative training provides students with opportunities for skills development that would not be available in academia alone, whilst allowing the partners to explore potential research collaborations or strengthen existing relationships.¹⁰⁹ The relatively modest level of business funding required makes it a particularly attractive mechanism for establishing relationships.
89. CASE studentships are allocated and awarded variably across the Research Councils. In general they are awarded through three different mechanisms: direct allocation to industrial partner organisations, known as Industrial CASE Partnerships; through open competitions run by the Research Councils; or through conversion of studentships awarded to a university as part of a Doctoral Training Partnership. Figure 14 provides an overview of the CASE schemes.

¹⁰⁷ *KTP Quarterly Statistics summary*, Innovate UK, March 2014

¹⁰⁸ *Key Attributes for Successful Knowledge Transfer Partnerships*, CIHE, 2012

¹⁰⁹ *Joint vision for collaborative training*, Research Councils UK, available at <http://www.rcuk.ac.uk/RCUK-prod/assets/documents/skills/rcdvision.pdf>

Figure 14¹¹⁰

	AHRC	BBSRC	ESRC	EPSRC	MRC	NERC	STFC
iCASE partnerships^a	-	75	-	210	-	-	-
Number of iCASE studentships pa	-	75	-	210	-	-	-
Number of industrial partner organisations	-	10 ^b (including KTN)	-	40	-	-	-
How are the partners selected?	-	Awarded to strategic industrial partners with established track records in collaborative doctoral training with BBSRC. Under review.	-	Algorithm based on financial & in-kind contributions to EPSRC funded research and training grants.	-	-	-
Total Number of DTP studentships awarded pa	974 (in 2014)	340	743 (in 2014) 600 notional	1200	155 notional	~240	-
Number of DTP CASE studentships pa	-	90	~16	120	Unknown	~72	-
% converted to CASE awards	-	~26%	20% collaborative ^c	10%	No target	~30% (50% of which have an industrial partner)	-
Number of CASE studentships awarded through open competition per year	90 CDAs ^d (18 with industrial partners), 18 KE-Hub CDAs (all with industrial partners).	-	-	-	~30-35	~35	~5
Number of CASE studentships awarded through other mechanisms	-	~35	-	-	-	-	-
Recent changes	-	Prior to March 2015, 125 studentships were awarded through open competition ^e	From 2017 the proportion of collaborative studentships will increase to 30%	A proportion of CASE studentships used to be allocated via the KTN	-	-	-
Engagement with SMEs	KE Hubs focus on engagement with SMEs	Encourage DTPs to engage SMEs with CASE studentships	Encourage DTPs to engage SMEs with CASE studentships	Pilot where large companies involve SME supply chain companies	SMEs are exempt from the required financial contributions from the non-academic partner. Focussed promotion.	CASE partner has to make a financial contribution of at least £1,000 pa. Set low enough for SME	Encourage engagement with SMEs

^a iCASE partnerships - block allocation of studentships are awarded to industrial partners
^b <http://www.bbsrc.ac.uk/business/training/industrial-case-partnerships/>
^c ESRC has a broader definition of collaboration compared to the other Research Councils, to date 50% of the 20% of collaborative activities have been collaborative studentships
^d AHRC CASE equivalent is Collaborative Doctoral Award (CDAs)
^e <http://www.bbsrc.ac.uk/news/people-skills-training/2015/150325-n-changes-to-icase-studentships/>

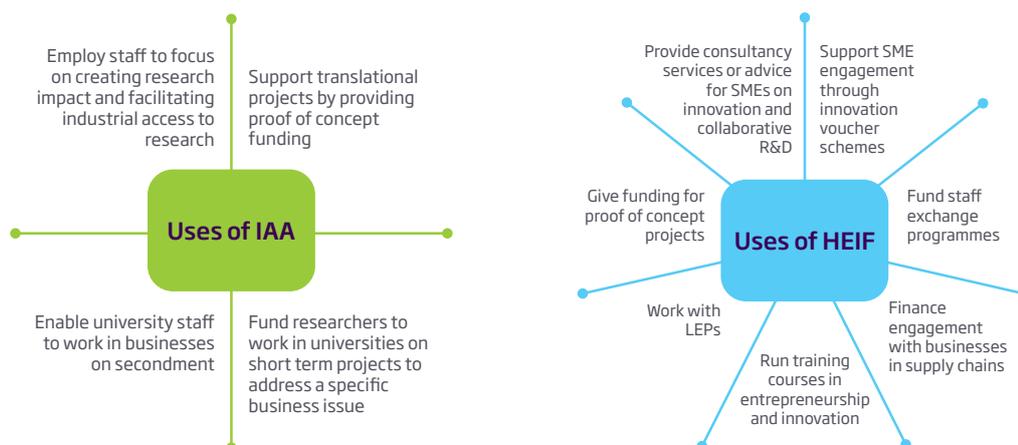
¹¹⁰ Information provided by Research Councils

90. While CASE studentships were widely praised as relatively low-cost routes to establishing partnerships, there were criticisms regarding changes to the eligibility criteria. Since 2011 EPSRC, the largest funder of CASE studentships, has stopped awarding CASE studentships via open competition and instead has been allocating 210 studentships per annum to 40 partner organisations with which they had significant prior interactions. BBSRC awards 75 studentships per annum to ten industrial partner organisations and since March 2015 has stopped access via open competition. Although all the Research Councils encourage conversions of studentships awarded as part of a Doctoral Training Partnership to CASE studentships the extent to which this is required, implemented and policed varies. By having multiple mechanisms for awarding CASE studentships, which also differ across the Research Councils, the system becomes complex and difficult to navigate. Furthermore, there are concerns that the current methods of CASE studentship allocation have restricted their availability to a relatively small number of large companies, despite efforts to increase engagement with SMEs (see Figure 14).
- **R15. CASE studentships are highly valued tools for establishing partnerships between industry and academia. The Research Councils should:**
 - **Use a standard model for allocation of and eligibility for CASE studentships and synchronise timelines wherever possible.**
 - **Increase the availability of CASE studentships to SMEs and to new business-university partnerships**, for example by creating a ring-fenced fund for studentships for SMEs and new partnerships that organisations with Doctoral Training Partnerships would bid into. **[RCs]**

Enabling universities to reach out

91. Universities carry out a wide range of engagement work aimed at stimulating collaborations with business. Of particular importance, as indicated in evidence submitted to the review was a need for universities to be able to quickly allocate relatively small amounts of money to kick-start collaborations until they are in a position to bid for greater, longer-term funding. Two funding mechanisms to support universities in their engagement with business stand out in this regard: Higher Education Innovation Funding (HEIF) and Impact Acceleration Accounts (IAAs). Although these two streams work with relatively small amounts of funding (in terms of overall spending on research), they both respond to an area of need. The flexibility of these schemes and the speed with which their funds can be directed to areas of demand make them vital in helping universities to develop research collaborations.
92. Having funding from these streams, which are devoted to supporting knowledge exchange activities, creates the slack in the system which academics need to lay the groundwork for collaborations. They can be used to free-up academic time from other commitments, thereby allowing academics to focus on developing proposals for collaborative research, doing the networking required to understand areas of research of interest to business, acquiring new skills to support business engagement, making the contacts that can kick-start collaborations, or funding a small-scale translational project.
93. The range of activities supported by these funding streams is illustrated in Figure 15. They were repeatedly cited in workshops and meetings as the source of funding for an array of different outreach events. These were particularly valuable when bringing academics and industrialists into contact with each other, or making the work of universities more accessible to businesses. For example, showcase events or industry open days have been used by universities not only to demonstrate the variety of research that they undertake, but also to demonstrate that they are open for businesses and welcome proposals for collaborative research.

Figure 15
Example uses of IAA and HEIF



94. HEFCE allocates HEIF on the basis of performance to universities which have achieved a certain threshold level of earnings from external income. This funding is intended 'to support and develop a broad range of knowledge-based interactions between universities and colleges and the wider world, which result in economic and social benefit to the UK'.¹¹¹ Eligible institutions have shared an allocation of £150 million a year between August 2011 and July 2015 from ring-fenced government funding and HEFCE.¹¹² The primary advantage of HEIF is its flexibility, with universities able to deploy these funds in response to demands from businesses or to develop new knowledge exchange projects.¹¹³ HEIF can also be used to fund university wide knowledge exchange infrastructure. Figure 15 illustrates the vital role that HEIF plays in underpinning university knowledge exchange and engagement with SMEs.
95. Similar schemes operate from funding bodies in Northern Ireland, Scotland and Wales. In Northern Ireland, the Department for Employment and Learning allocates £4 million in NI HEIF 'to encourage the higher education sector to increase their capability to respond to the needs of business (including companies of all sizes) and the wider community, with a clear focus on the promotion of wealth creation'.¹¹⁴ In Scotland, the Scottish Funding Council allocates the Knowledge Transfer Grant to support university knowledge transfer work, taking into account the Scottish government's priorities.¹¹⁵ It is allocated via two mechanisms from a general and dedicated fund.¹¹⁶ In Wales, HEFCW's Innovation and Engagement Fund formerly provided £8 million per annum to help universities commercialise their research but this has recently been withdrawn.^{117 118}
96. HEIF's flexibility means that a university is able to respond quickly when it finds a business need which it could help to address. In addition to business engagement, HEIF has also been used to support work with LEPs and to encourage entrepreneurship (both business and academic).¹¹⁹ It can also be used to support the work of university

¹¹¹ *University HEIF strategies*, available at: <https://www.hefce.ac.uk/kess/heif/strategies/>

^{112 113} HEIF policy and allocations, available at <https://www.hefce.ac.uk/pubs/year/2011/201116/>

¹¹⁴ NI Higher Education Innovation Fund, information available at: <http://www.delni.gov.uk/index/further-and-higher-education/higher-education/role-structure-he-division/knowledge-transfer/higher-education-innovation-fund.htm>

¹¹⁵ *Knowledge Transfer Grant consultation*, Scottish Funding Council, 2013

¹¹⁶ SFC Knowledge Transfer Grant, information available at: <http://www.sfc.ac.uk/FundingImpact/KnowledgeExchange/Universities/KnowledgeTransferGrant/KnowledgeTransferGrant.aspx>

¹¹⁷ HEFCW funding and initiatives, information available at: https://www.hefcw.ac.uk/policy_areas/business_and_communities/funding_initiatives.aspx

¹¹⁸ *HEFCW submission to Finance Committee*, National Assembly of Wales Finance Committee, 2014

¹¹⁹ *Select committee endorses importance of HEFCE knowledge exchange funding*, HEFCE, 2014

Technology Transfer Offices, the role of which is discussed later in this Review. As a result of these activities, it is estimated that HEIF has delivered a return of £6.30 gross additional income for universities for every £1 invested over the period 2003–2012.¹²⁰ The effectiveness of HEIF should be considered proven. Yet universities expressed repeated concerns over whether this funding will remain available in the longer-term.

97. Impact Acceleration Accounts (IAAs) are a recent addition to the Research Councils' funding portfolio and are used to support knowledge exchange and innovation activities. They were first introduced in 2012 by EPSRC and have now been piloted by four other Research Councils. The funding is allocated as a block grant to individual research organisations across the UK, based on their previous success in securing funding from the Research Councils and dependent upon submission of a satisfactory business plan. Once allocated, an organisation is able to decide for itself how to deploy this funding using a broad set of objectives (see Figure 15 for examples of applications of IAA funding).
98. IAA funding has been particularly useful to help transfer results from Research Council funded research into industry through short-term secondments. The funding cannot be used for the generic support of translational activities that the research organisation should be funding themselves or from their HEIF awards (or equivalents), such as patent filing and IPR registration. The duration and amount of funding awarded varies according to the Research Council, with ESRC and EPSRC's largest awards capped at just under £1M and STFC issuing awards of £50,000. For those organisations in receipt of this funding, IAAs are useful in creating space for academics to pursue knowledge exchange work. IAAs are particularly valued for the speed with which the funding can be mobilised and deployed.
99. As the government considers the future shape of financial support for knowledge-exchange activities, it must take note of the importance of flexibility to enable universities to respond to business need. It should also recognise the value in stability in funding schemes to allow businesses to familiarise themselves with the support on offer.
 - **R16. Higher Education Innovation Funding is an important and much valued funding mechanism for supporting universities' capacity to engage with businesses. Government should make a long-term commitment to maintaining a form of flexible funding for knowledge exchange as a means of stimulating translational activity and collaboration. [Govt/FCs]**
 - **R17. Impact Acceleration Accounts (IAAs) have also proved effective and should be offered across all the Research Councils. The approach to allocating or applying for IAAs should be common across the Research Councils. [RCs]**

Growing critical mass

100. Scaling up of collaborations so that they evolve into a critical mass of activity, with multiple points of contact, a clear framework and a longer-term horizon, is key to unlocking the full potential of the strategic relationships that represent the focus of this review.
101. Some of the most challenging and exciting research occurs when a core group of researchers is informed about areas or developments that would make a long-term difference to a particular company or sector, and embark upon a sustained

¹²⁰ *Knowledge exchange performance and the impact of HEIF funding in the English Higher Education Sector*, HEFCE, 2014

research programme to bring about that change. This type of use-inspired research is quite different from short-term industrial research; it is aimed at developing the understanding, capability and people needed to make a radical difference in the mid to long-term.

102. A number of agencies have run schemes aimed at building capacity within the research base and have funded the scaling up of partnerships between businesses and academics. For example, EPSRC made a £12.9 million investment in 2013 to create the UK Catalysis Hub: a collaborative project between universities, industry and EPSRC, located alongside other major scientific facilities in the Research Complex at Harwell, Oxfordshire.¹²¹
103. In addition, the Research Councils have previously demonstrated the benefits that can be achieved by providing funding for growing critical mass in specific research areas. For example, EPSRC, in conjunction with the UK funding bodies, provided support to grow capacity in specific research areas through the Science and Innovation Award programme.¹²² This programme provided large value, long-term grants in strategically important research areas that were identified as being missing or 'at risk' in the UK.¹²³ It operated in partnership with HEFCE, the Scottish Funding Council, the Higher Education Funding Council for Wales and the Department for Employment and Learning in Northern Ireland, awarding grants with a value of approximately £120 million to 29 research programmes. Examples of research activity supported via the Awards included:
- Imperial College London and London School of Economics: Centre for Synthetic Biology and Innovation
 - University of Manchester and Lancaster University: Centre for Innovation through Materials Science, Chemistry and Engineering
 - University of Edinburgh and Heriot-Watt University: Centre for Carbon Capture
 - University of Cambridge: Energy Efficient Cities initiative
 - Cardiff University: Centre for Integrated Renewable Energy Generation and Supply¹²⁴
104. This funding stream focused on capacity building in an area of research, rather than building critical mass in collaborations between an established research group and industry partner, but its success highlights the potential utility of such funding in producing lasting benefits to the research and innovation community. Indeed, an evaluation of its success suggested that further industrial engagement could enhance the sustainability of the research groups established via this mechanism.¹²⁵
105. The National Academies also run various schemes aimed at stimulating collaboration, albeit at a smaller scale. For example, the Royal Academy of Engineering funds Research Chairs in partnership with industry with the aim of establishing centres of excellence focussed on challenges that matter to industry. Experience with schemes such as this suggests that public support at the outset of a collaboration to establish a strong core team would lever substantial industry and grant funding over the longer term and give a robust return on the initial investment.¹²⁶ It would also provide a stimulus for scaling up the coverage and scope of collaborations.

¹²¹ [£12.9 million investment promises stronger, greener UK](#), EPSRC news article, 2013

¹²² The programme concluded in 2010/11: [Annual report and accounts 2010–2011](#), Engineering and Physical Sciences Research Council, 2011

¹²³ [Review and evaluation of the science and innovation awards portfolio](#), Engineering and Physical Sciences Research Council, 2011

¹²⁴ A full list of awards made is available in [Review and evaluation of the science and innovation awards portfolio](#), Engineering and Physical Sciences Research Council, 2011

¹²⁵ [Review and evaluation of the science and innovation awards portfolio](#), Engineering and Physical Sciences Research Council, 2011

¹²⁶ For example, Royal Academy of Engineering industry co-funded Research Chairs typically attract £11 in third party funding for every £1 of support from the scheme, with nearly all collaborations continuing once funding from the scheme finishes. <http://www.raeng.org.uk/publications/strategy-and-finance/raeng-an-introduction-brochure>

106. As discussed above, for companies to share their long-term industrial strategy with academic researchers there needs to be complete trust between them. The academics also need to be open to new challenges and willing to devote time to work out what technologies are really needed by industry and to understand what constrains implementation at scale. If both parties are willing to do this, the benefits for each can be considerable: the academics do world class research that is recognised by their peers to be transformational and the industry partner can bring innovative products to market and get a lead on its competitors.
107. Most funding schemes provide early-stage support for collaborative relationships, are limited to funding a single project, or are offered as part of managed calls for projects within specific subjects. A high-profile initiative to encourage capacity building and the scale up of university-industry interactions from collaborations that revolve around a single researcher and focus on near-term objectives to a strategic long-term partnership could make a very valuable contribution and fill a gap in current provision. It would take the form of a pump-priming funding scheme that would provide a means of investing in a small group of collaborating Principal Investigators who would have complementary areas of expertise and would conduct research in areas relevant to a particular company or sector. It would also help to cement the link between research excellence and industrial relevance, by explicitly targeting projects which fit both criteria.
108. These 'Awards in Collaborative Excellence' (ACE) would require government funding to support the employment costs of the core group of researchers for an initial period of five to seven years, in order to allow the collaboration to take root. The industry partner would be expected to commit to funding research projects carried out in this team – and while the amount of funding committed would be agreed up-front, the specific focus of the research projects would not. The university or research institute would need to commit space and PhD studentships etc in support of the research, as well as underwriting the appointments of the core staff after the end of the pump-priming period. Additional commitments may be made using regional funding. To ensure the integrity of the scheme, grants would be awarded on the basis of the excellence of the proposed research programme, the quality of the research team and the strength of the commitment from all parties. The profile of the scheme, competitive selection process and size of the award available would ensure that alliances supported had strategic visibility and priority for both the academic and industrial partner.
109. An important component of the scheme would be the provision to enable the core researchers to get to know the company well, for example through spending some time in the company on secondment. This would build mutual trust with the company and allow the researchers to become privy to the long-term strategic aims of the company and how these feed through to required breakthroughs in technology. This in turn would shape the focus of the academic team's research. The research endeavour would need to be quite broad in order to make a substantive difference so the ability to support a group, rather than a lone individual is important. As already happens for Royal Society Industrial Fellows and Royal Academy of Engineering industry co-funded Research Chairs, the research team would be supported by a mentor with previous successful experience of university-industry collaboration.
- **R18. There is a need for a new public and private co-funded scheme that would provide pump-priming funds on a competitive basis to enable strong relationships between individuals in academia and industry to transition into group collaborations with critical mass, substantial industry funding and a long-term horizon. These 'Awards in Collaborative Excellence' (ACE) would make a substantive contribution to scaling up the overall collaborative effort in the UK. [Govt/RCs/IUK]**

Terms of engagement

110. Finding partners and sources of support are necessary but not sufficient to build a long-term collaboration. An essential next step is the agreement of the terms of engagement. The review received a large volume of evidence asserting that this could in fact be the most frustrating and problematic element of developing a collaboration, with a wide range of explanations and solutions offered.

Technology Transfer Offices

111. Technology Transfer Offices (TTOs) play an increasingly important role in mediating business-university collaborations, including in defining the terms of engagement. They can provide advice and expertise in areas including: business development, contracting, IP protection and technology licensing. TTOs operate at the interface of businesses and universities, and may act as a gateway between the two. The UK TTO system is argued to be world-leading in many respects and has been shown to be important in supporting academic interactions with business and helping to initiate relationships.^{127 128}
112. When effective, TTOs can be the brokers that bring partners together and integrate business needs with university resources. Their role is fundamentally about accelerating knowledge exchange and technology transfer through providing a supportive interface between academia and business and bringing the relevant parties together. This role should be reflected in how they are assessed and funded.
113. The approach to funding and measurement of success reflects institutional expectations of TTO activities. These factors subsequently affect how TTOs operate and how their work is perceived by the community. Asking TTOs to generate income to ensure their survival or measuring their success as a function of near-term income generated therefore engenders the perception that their primary focus is on income rather than on supporting collaboration and the delivery of long-term benefits from research. The Intellectual Property Office recognises this in its guide to *Intellectual asset management for universities*, which states that 'Universities should consider their IPR strategies as part of their research strategy rather than their earned income strategy'.¹²⁹ This approach should govern what universities expect of their TTOs and how they therefore operate. The lack of clarity in high-level messages from government and public funders in this space has been noted previously. For example, the report on IP management in universities led by Peter Saraga CBE FEng for the Funders' Forum described 'confusion as to whether the primary aim of collaborative research should be to generate income for universities or to create benefit for the wider community'.¹³⁰
114. While it is reasonable and proper for universities to protect their IP, the objective of earning income from it needs to be tensioned against the role of universities in advancing knowledge and facilitating its exploitation for the public good, especially where public funding has enabled the generation of the IP in the first place. If universities expect TTOs to generate sufficient income to cover their costs and provide an additional revenue stream for the university, it is highly likely that this broader role will be underplayed. There are sources of funding, such as HEIF and the indirect costs covered by full economic costs, which can be used support the costs of TTOs.¹³¹

¹²⁷ *Collaborate to innovate: How business can work with universities to generate knowledge and drive innovation*, Big Innovation Centre, 2013

¹²⁸ PraxisUnico submission to the Dowling Review, PraxisUnico, 2015; *Russell Group evidence to the Science and Technology Committee*, Russell Group, 2013, para 3.1

¹²⁹ *Intellectual asset management for universities*, IPO, 2013

¹³⁰ *Streamlining university/business collaborative research negotiations: an independent report to the Funders' Forum of the Department for Innovation Universities and Skills*, 'The Saraga Review', 2007

¹³¹ An explanation of full economic costs is available here: <http://www.rcuk.ac.uk/RCUK-prod/assets/documents/documents/fecFAQ.pdf>

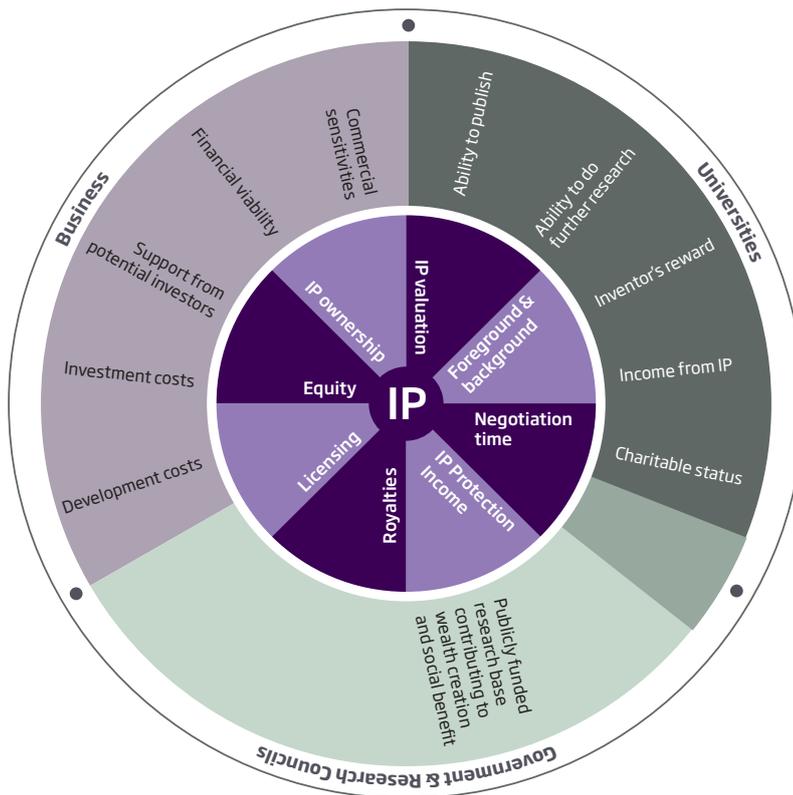
115. It is also essential that the incentive structure surrounding TTOs reflects this broader mission. A good example is provided by Cancer Research Technology (CRT), which works in partnership with Cancer Research UK to identify innovative scientific and business solutions to unmet needs in cancer, embodied in the vision ‘Advancing Discoveries to Beat Cancer’. CRT’s development and commercialisation activities are focused on driving delivery of the new Cancer Research UK research strategy, and this is also reflected in the metrics used to measure CRT’s performance. While CRT may not be a typical TTO, there is no reason why the principles underpinning its approach should not be more widely applicable. It is also worth noting that TTOs should measure their success over suitably long timescales: focusing on near-term results can drive behaviours that are counterproductive over the timescales that matter.
116. More generally, it is likely that the public funding supporting knowledge exchange and collaboration would be used more efficiently if TTOs undertook more pooling of skills, sector knowledge and technical expertise. There are already examples of universities and TTOs working in collaboration, as well as mechanisms for informal sharing of expertise by TTO staff.¹³² Wider adoption of such approaches could both help the performance of individual institutions and deliver broader public benefits.
- **R19. TTOs are important players in the collaboration process. In order to strengthen the role that they play:**
 - a **Universities** should consider their approach to IPR as part of their research strategy rather than their income generation strategy. They **should ensure that the overarching metric used to assess the success of TTOs is their effectiveness in supporting translational activities over the longer term, not short-term revenue generation.**
 - b **Universities that are confident of the performance of their TTO in supporting the establishment of collaborations should publicise statistics that highlight their efficiency and effectiveness.** These could include metrics such as the average time taken to agree contracts, the satisfaction rating given by their industrial partners and the amount of repeat business achieved.
 - c **TTOs and universities should work collaboratively, across institutional boundaries, to share expertise, sector knowledge and best practice. [Univs/TTOs]**

IP and contracting

117. Creating R&D contracts is an inherently complicated process, often involving asymmetry in the motivations and expectations of the contracting parties, uncertainties around what will be delivered and long-term time horizons. There is widespread agreement that IP is an issue hindering the development of collaborations (Figure 12), but no clear vision for how to make this easier. In this context, it seems that IP is sometimes used as shorthand to describe a whole host of issues relating to contract development, such as indemnities, warranties, exclusivity or publishing.
118. Given the range of factors at play, it may be unrealistic to expect developing R&D contracts to ever be a straightforward exercise. As with any negotiation, parties have different and sometimes contradictory aims, as illustrated in Figure 16, which can make discussions complex. For example, academics need to be able to publish the results of their research and IP is particularly important for SMEs to ensure business survival.

¹³² E.g. The SETsquared Partnership is an enterprise collaboration between five research-intensive universities: Bath, Bristol, Exeter, Southampton and Surrey and the PraxisUnico Directors’ Forum provides a platform for sharing knowledge across TTOs.

Figure 16



For research to be regarded as charitable:

the research must further charitable aims and be conducted for the public benefit;

the subject matter of the research must be a useful subject for study;

the knowledge acquired from the research must be disseminated to the public within a reasonable timeframe;

any private benefits must be 'incidental' to achieving charitable purpose; that is, reasonable, necessary and in the interests of the charity.

Getting through these discussions requires that both parties see the value in reaching agreement and that there is sufficient mutual understanding for businesses and universities to appreciate the motivations and constraints that each side is operating under.

119. The Lambert toolkit is a set of decision tools and standard agreements created in 2005 with the aim of simplifying contract negotiations for business-university collaborations. While the toolkit contains plenty of thoughtful and helpful information, there is little evidence that the standard agreements are being widely used or that companies want to use them. It has been estimated that less than 10–15% by value of collaborative research between universities and business in the UK is based on a Lambert-like agreement.¹³³ On the other hand, almost 80% of those who were aware of the toolkit reported that it simplified the process of constructing contracts, and provided useful information and precedents.¹³⁴

120. The Lambert toolkit is focussed on establishing agreements for new collaborations. In the case of IP generated prior to the start of a collaboration, known as 'background IP', it seems reasonable that the government should express a view on the basic principles to be followed where the IP has arisen directly from publicly-funded research. Establishing these principles, and communicating them effectively, could simplify the process of setting up agreements with businesses wishing to utilise the IP, as well as ensuring that the maximum public benefit is derived from research that has been funded from the public purse. The principles would define best practice rather than act as a legal framework and the universities would continue to own the background IP.

¹³³ NB. It was never intended that Lambert agreements would be suitable for all types of collaboration.

¹³⁴ *Collaborative Research between Business and Universities: The Lambert Toolkit 8 Years On*, IPO, 2013, p4

121. As previously mentioned, Universities Scotland has set out a five point plan to further enhance business-university engagement in Scotland. The second point of Universities Scotland's five point plan is *'Harmonising and simplifying contract negotiations'*. It aims to do this by going a step further than the Lambert toolkit and mandating the use of template contracts for interactions funded by the SFC's innovation voucher and related schemes. This has been partly motivated by the fact that the legal fees incurred through negotiating contracts for these interactions have often been out of proportion to the maximum £5000 value of the vouchers. SFC has mandated the use of the agreed standard contracts for Innovation Vouchers and discussions are underway to consider adopting template contracts for all business-university collaborations in Scotland where public funding is provided, in a bid to improve the economic outcomes of public research funding.
122. Views amongst contributors to this review about the use of standard contracts were heavily polarised with some arguing vehemently that these were the only way to tackle this vexatious issue and many others arguing equally forcefully that a 'one size fits all' approach would never work. The pilot being undertaken in Scotland provides a useful opportunity to test the merits of these respective arguments and needs to be monitored carefully by the UK government.
123. While there may not have been fulsome support for a unified approach to contracting, the Research Councils have had some success in utilising template agreements which were developed with appropriate expert input. For example:
- MRC developed the Model Industry Collaborative Research Agreement (mICRA) with the National Institute for Health Research as a model agreement that can support all clinical collaborative research scenarios involving the pharmaceuticals and biotechnology industries, academia and NHS organisations. The MRC mandated its use for a partnership with AstraZeneca resulting in 15 collaborative research agreements being signed within three months of a funding decision being taken by the MRC.
 - A single framework of arrangements for handling IPR and research exploitation was developed for the EPSRC-funded national network of Quantum Technologies Hubs, which all 17 participating HEIs have agreed to use. The framework was drafted collaboratively and comprises several tools to assist with making the most appropriate decision for each given circumstance.
124. Many contributors also noted that for large-scale and/or long-term collaborations, having an overarching agreement for a partnership negated the need for time-consuming negotiations on each individual project. Several examples of the success of umbrella agreements were cited in evidence, with early agreement of a framework for collaboration between a company and university (and frequently between multiple partners) enabling numerous collaborative projects to be undertaken without separate contracts having to be negotiated. Such approaches only worked when accompanied by good project governance, usually involving an integrated steering group and very regular and open communication.
125. Even if changes such as these could help to reduce some of the unnecessary complexity in negotiations regarding IP and other terms, SMEs that are coming to collaborations for the first time or have limited experience of collaboration are still likely to find the process daunting and confusing. Several respondents from SMEs commented on the fact that being presented with a weighty contract by a university meant that they were inclined to just walk away from the collaboration since seeking legal advice would be costly and time-consuming. They also commented on the difficulty of calibrating their expectations against the position adopted by the university that they were negotiating with. In circumstances such as these, it could be extremely helpful if SMEs were able to access

independent, expert advice to help them understand what to expect and how to steer a course through the process of negotiating the contract. This would not be a substitute for formal legal advice but would allow them to access personnel with experience and knowledge of the process of contract negotiation. The wider topic of SME support is addressed in the next chapter and it will be important for any advice on contracting to be accessible through the mechanisms described there.

- Notwithstanding the substantial efforts already devoted to improving the approach to establishing contracts and IP agreements between universities and businesses, this remains a confounding factor for collaboration and is a major source of frustration for both academics and businesses. While there seems to be little appetite for enforcement of standard contracts for business-university collaborations, there are examples of model templates being used successfully. Furthermore:
 - **R20. The Intellectual Property Office (IPO) and Department for Business, Innovation and Skills should define principles for commercial use of background IP created through publicly-funded research. [IPO/Govt]**
 - **R21. The Research Councils and Innovate UK should build on their own successful experiences and invoke template agreements wherever appropriate**, especially when supporting collaborations involving multiple universities and/or businesses. In addition, the approaches being piloted in Scotland need to be monitored closely. **[RCs/IUK]**
 - **R22. Innovate UK, in consultation with the IPO, should explore the establishment of an independent source of advice and expertise that SMEs could call upon for support in negotiating contracts with universities. [IUK/IPO]**
 - **R23. There is scope for all parties, including the Research Councils, Innovate UK, funding councils, universities, businesses and organisations which represent TTOs to promote examples of better practice in relation to IP and contracts and facilitate their utilisation across the community. [RCs/IUK/FCs/Univs/TTOs/Bus]**

4. Setting course: government strategies to support innovation

Industrial and innovation strategy

Innovation and universities

126. The development of industrial strategy and targeted support for key sectors and technologies represents a significant shift in the UK landscape for collaboration. The strategy – and the process by which it has been created – has helped to coordinate resources and bring together the different players in a sector within a common framework to articulate plans for the future development of their sector. It has also enabled the development of technology roadmaps for the priority sectors, through which members of the core community have come together to define future technology challenges.
127. Industrial strategy and the activities undertaken in support of it need to recognise the role that universities can play in both influencing and delivering elements of the strategy. Moreover, industrial strategy does not operate in isolation: there have been a number of other strategies developed in recent years which rely on research and innovation for future success, including Science and Innovation, Life Sciences, Water and Local Growth.¹³⁵ However, the mechanisms to ensure complementarity and achieve coordination between these are at best unclear and at worst entirely lacking. The timescales over which research and innovation operate and their broad relevance to many aspects of policy mean that support for these areas needs to be long-term, adopt a systems view of relevant policies and their interactions, and be able to withstand changes in the political weather.
128. Within this context, encouraging businesses to undertake research in collaboration with universities can be a particularly productive means of industrial support, as the business impacts of engaging in projects with academic partners can be more than double those achieved in projects that do not involve any academics.¹³⁶ Yet despite the significance of innovation to future industrial development, and the growing recognition of the economic importance of universities,¹³⁷ there is little evidence that universities were consulted in the development of the industrial strategy in a consistent manner, or that they are generally seen as partners in its implementation.¹³⁸ Reflecting this, there was a very low awareness and understanding of the industrial strategy amongst many of the academics who contributed to this review. This would seem to be a missed opportunity, especially since there was strong demand from academics for an improved understanding of UK national strategy in relation to innovation. The lack of understanding about the UK approach contrasted with views of countries like Germany

¹³⁵ *Our plan for growth: science and innovation*, Department for Business, Innovation and Skills, 2014; *Strategy for the UK life sciences: one year on*, HM Government, 2012; Future water: *The Government's water strategy for England*, HM Government, 2011; *Local growth: realising every place's potential*, HM Government, 2010

¹³⁶ An analysis of the impact of Innovate UK's collaborative R&D funding showed that business impacts in projects with two or more academic partners were more than double those in projects with no academic partners: £9.67 GVA per £ spent, versus £4.22 GVA per £ spent. 2013: *Evaluation of the Collaborative Research and Development Programmes*, Innovate UK, 2013

¹³⁷ *Encouraging a British Invention Revolution: Sir Andrew Witty's Review of Universities and Growth*, 'The Witty Review', 2013

¹³⁸ The Life Science strategy development was cited as an example of good practice in terms of engagement with universities and the wider research community.

and the Netherlands, where there was perceived to be much greater clarity – amongst all partners involved in innovation activities – on national and regional priorities for innovation.

- **R24. Government needs to treat research and innovation as an integral part of industrial strategy. Furthermore future developments in industrial strategy should include innovation as a key cross-cutting theme. When developing industrial strategy and other long-term sectoral strategies, government and business should consult universities as key partners. Innovation should be a core component of policies aimed at promoting productivity and competitiveness, with full consideration given to its role in different sectors. [Govt/Bus]**

Encouraging business investment in UK R&D

129. As discussed in chapter two, the UK suffers from low levels of business investment in R&D, which poses a potential barrier to collaboration. Industrial strategy and the framework for support for key sectors and technologies provide powerful levers for stimulating business investment in R&D. The sector leadership councils act as platforms to convene private sector stakeholders, with major corporates bringing with them potentially valuable links to a wide range of SMEs through their supply chains. The perceived success of the early priority sectors has also led to demand from sectors not currently represented to be included in future iterations of the strategy. In view of the significance of research and innovation activities for industrial strategy, a sector-wide commitment to an increase in R&D – or associated investments in innovation and manufacturing capability in the UK – would be an appropriate criterion to be used in selecting future priority sectors. The impact of this approach would be amplified if government also committed to provide an increase in R&D investment of relevance to the sector, in proportion to the increase in private investment secured. Innovate UK would be the natural lead for both monitoring the R&D expenditure levels across the sector and managing the matched funding stream provided by government.

- The industrial strategy and prioritisation of key sectors and technologies provide a valuable opportunity for government to promote private sector innovation and R&D investment.
 - **R25. Government should prioritise increasing public investment in R&D in industrial sectors of strategic importance, conditional on a commensurate increase in investment in associated activities by business. Innovate UK should be tasked with monitoring investment levels in R&D across industrial strategy sectors and managing the matched funding stream from government. [Govt/Bus/IUK]**
 - **R26. A commitment for a sector-wide increase in business investment in R&D and associated activities should be a qualifying condition for the admission of new sectors to the industrial strategy (subject to the government co-investment referred to above). [Govt/Bus]**

130. The tax environment also sets incentives for collaboration and can be used to encourage businesses to invest in R&D. From 1 April 2015, the R&D tax credit for SMEs provides tax relief on allowable R&D costs of 230%. So, for each £100 of qualifying costs, an SME could have the income on which Corporation Tax is paid reduced by an additional £130 on top of the £100 spent.¹³⁹ For large companies, tax relief on allowable R&D costs is 130%.¹⁴⁰ The government's Patent Box also provides Corporation Tax relief on profits earned from patented inventions or other innovations.¹⁴¹

¹³⁹ ¹⁴⁰ R&D tax relief, information at: <https://www.gov.uk/corporation-tax-research-and-development-rd-relief>

¹⁴¹ Corporation tax relief, information at: <https://www.gov.uk/corporation-tax-the-patent-box>

131. Many businesses evidently consider these tax measures valuable in creating an environment which supports R&D. Government analysis of the impact of R&D tax credits indicates that up to £3 of spending on R&D is stimulated for each £1 of tax foregone, with companies indicating their belief that these tax credits have contributed to an increase in R&D overall.¹⁴² Over 15,000 companies claim around £1.4 billion via these measures each year.¹⁴³ In 2012–13, the SME scheme accounted for over 80% of these claims by number.¹⁴⁴
132. However, while R&D tax credits stimulate R&D expenditure, there is nothing within this system which encourages that R&D to be carried out in collaboration with universities. There is also confusion over the interaction between the R&D tax credit and State Aid rules. SMEs are still eligible to apply for the 'large company scheme' whilst in receipt of other funding without getting into State Aid difficulty. But guidance on this is not well understood, and use of the term 'the large company scheme' undoubtedly adds to the confusion.
- **R27. Much clearer guidance from HMRC and BIS is needed for businesses on how they can make best use of R&D tax credits and how these interplay with State Aid restrictions. [Govt]**

Open innovation and pre-competitive research

133. The open innovation model has received significant attention in recent years. Organisations that have embraced open innovation look externally for innovative developments instead of relying on internal research and innovation; they also allow internally generated inventions to be exploited outside of the company. For firms to excel at open innovation they require the absorptive capacity gained through appropriately skilled individuals who are capable of recognising and exploiting relevant opportunities. Such skills can be developed through schemes that support people mobility, as discussed in chapter two. Amongst the earliest and most enthusiastic adopters of such an approach have been the pharmaceutical companies, with several examples of joint campus development and other vehicles of open innovation now well advanced.¹⁴⁵
134. Precompetitive research is undertaken to address challenges that have significance across a sector and often involves partnerships with multiple industry partners. Collaborative work of this nature can be valuable for tackling shared issues, such as environmental challenges, and can raise standards across a sector by offering insights into new techniques or potential efficiencies. One of the most successful examples is considered to be the Structural Genomics Consortium outlined in Box 6.
135. Suitable topics for precompetitive research often emerge during the development of roadmaps or strategies across a sector as these highlight common technological challenges and needs. There is therefore an obvious potential link with industrial strategy activity and an opportunity for common challenges across a sector to be pursued on a pre-competitive basis.

¹⁴² *Evaluation of Research and Development Tax Credits*, HMRC, 2010. This analysis does, however, note that there is little evidence of any effect on decisions about whether or not to proceed with individual R&D projects.

¹⁴³ *Improving access to R&D tax credits for small business: consultation summary*, HMRC, 2015

¹⁴⁴ *Evaluation of R&D tax credits*, HMRC, 2015, which states: "in 2012–13, 12,650 companies made claims under the SME scheme for a total of £600 million in tax credits".

¹⁴⁵ Examples available in: *Open Innovation in the NHS*, Academy of Medical Sciences, 2014

Box 6. Structural genomics consortium

The Structural Genomics Consortium (SGC) is an example of how open innovation can operate across a public-private partnership in the pre-competitive space. The primary focus of this consortium is structural biology – determining the 3D structure of proteins – with emerging additional work on epigenetics and antibodies. Public, private and charitable funding bodies contribute to the SGC annually and, in return, are able to take a seat at the SGC's board, where they can help determine the consortium's future areas of research.¹⁴⁶ The SGC now has over 250 open access collaborations with researchers across the world.¹⁴⁷

The SGC is part of a wider trend in biomedical research, which favours pre-competitive research in the field of drug discovery.¹⁴⁸ In the past, the pharmaceutical industry has felt it necessary to invest in strong patent coverage, in order to justify the investment required to develop new drugs. This requirement discouraged collaboration with other organisations. However, the sector is now developing new models of drug discovery which rely on an open innovation approach, including a focus on pre-competitive research, which reduces the costs of failure when developing new treatments by encouraging collaborations with academia and other industrial partners.

One of the key attributes of the SGC is that its research is made publicly available. Since 2004, the SGC has deposited the structures of over 1100 proteins in the Protein Data Bank, produced over 450 peer-reviewed journal publications and had a presence at over 250 conferences worldwide.¹⁴⁹ Benefits of the SGC include:

- New areas of research are “de-risked” for industry, through the inclusion of public-sector funding.
- Diverse partnerships and collaborations can be developed, as a result of the consortium's wide network and open access policy.
- It is easier to set up new contracts and collaborations, as difficult negotiations on IP are avoided.
- Research happens more rapidly and efficiently, through the use of clear milestones with defined outputs.
- Results of research are reproducible by industry partners.
- Duplication of effort by industry partners is avoided.¹⁵⁰

- **R28.** Pre-competitive research has been identified as an area where effective long-term relationships can be established across a range of partners. **Government and sector leadership councils should ensure that industrial strategy sector activities build in opportunities to support pre-competitive research on a collaborative basis**, making use of the roadmaps developed to identify key challenges for the relevant sector. **[Govt/Bus]**

Supply chains

136. Large companies can act as traction engines that pull through the development of smaller companies in their supply chains, and mechanisms that encourage large companies to involve small companies in their collaborations with universities can be effective ways of encouraging engagement with SMEs. Collaborative R&D activities involving corporates, companies in their supply chains and universities can be extremely fruitful but there have been regrettable examples of supply chain-focussed R&D initiatives undertaken under the auspices of industrial strategy that have excluded participation by university partners, which seems counterproductive and difficult to justify.

¹⁴⁶ *The Structural Genomics Consortium: a knowledge platform for drug discovery*, RAND Europe, 2014

¹⁴⁷ *The next frontier*, International Innovation, 2014

¹⁴⁸ *The Structural Genomics Consortium: summary*, RAND Europe, 2014

¹⁴⁹ ¹⁵⁰ *The Structural Genomics Consortium: a knowledge platform for drug discovery*, RAND Europe, 2014

137. Another mechanism for engaging supply chains in innovation activities is provided by the Small Business Research Initiative (SBRI) run by Innovate UK. This scheme offers contracts ‘to research and develop a new product or service for the public sector’, providing initial funding of £50k to £100k to test an idea, with the possibility of a further £1 million contract (or more) to develop it.¹⁵¹ The overall aim is to stimulate the private sector to develop innovative solutions to challenges in the public sector.¹⁵²
138. The SBRI has not yet met the expectations placed on it by government or the research community and is widely perceived to be less successful than the US Small Business Innovation Research (SBIR) model. In 2013–14, £78.5 million of contracts were awarded via the SBRI mechanism, falling short of the target of £100 million.¹⁵³ An evaluation of the SBRI is currently being carried out by the Department for Business, Innovation and Skills, which is considering the processes to deliver the initiative, its impact on businesses involved and baselines against which to measure future impact.¹⁵⁴ This evaluation offers an opportunity to further consider the potential for the scheme to encourage collaboration with universities and how the scheme integrates with other knowledge exchange activities. An example of such integration is provided below.

Through a Knowledge Transfer Partnership (KTP), researchers at the University of Liverpool helped Polyphotonix, an SME developing organic lighting products and technologies to develop the capabilities to exploit this technology into a treatment to halt degeneration in patients with two classes of eye disease. The technology is being developed with the help of a Small Business Research Initiative (SBRI) contract from an NHS Long Term Conditions competition.¹⁵⁵

- **R29. Government should maximise the opportunities provided by the SBRI to foster business-university collaboration, including by facilitating the formation of new partnerships for commercial exploitation amongst potential bidders. [Govt]**

NHS

139. The NHS is a key player in the research collaboration landscape for the life sciences. If government wants to encourage further business-university collaboration in this sector, it therefore needs to consider how to make the NHS an attractive place to carry out such research. In some ways, the factors contributing to the success of research collaborations in the NHS are no different to those elsewhere: it is necessary to have trusting and open relationships between research partners, based on mutual understanding and respect.
140. The challenges may also seem familiar. The size and complexity of the NHS act as barriers to collaboration, with finding potential opportunities once more an issue and spreading best practice in collaborative research difficult. It can also be a challenge to integrate innovation in the incentive framework for NHS staff. A specific, recurring source of concern was the extent to which the NHS is able to support research partnerships between industry and academia in the medical sciences. Such partnerships can help accelerate the rate at which new developments in medical science are developed into new treatments for patients. The barriers to innovation in the NHS are relatively well-known, and have been the subject of previous reviews (Box 7).

¹⁵¹ Innovate UK funding: <https://www.gov.uk/innovation-get-details-about-innovate-uk-funding-competitions>

¹⁵² SBRI website: <https://sbri.innovateuk.org/>

¹⁵³ *Government response to the Business, Innovation and Skills Committee report on Business-university collaboration*, Department for Business, Innovation and Skills, 2015, para 11

¹⁵⁴ *Government response to the Business, Innovation and Skills Committee report on Business-university collaboration*, Department for Business, Innovation and Skills, 2015, para 10

¹⁵⁵ *Response to the Dowling Review*, Russell Group, 2015

Box 7: The NHS and innovation

Innovation has been defined in the NHS as:

An idea, service or product, new to the NHS or applied in a way that is new to the NHS, which significantly improves the quality of health and care wherever it is applied.¹⁵⁶

Previously identified barriers to encouraging innovation have included: poor access to evidence or data, insufficient recognition of innovators, ineffective financial levers, individuals in management or leadership positions lacking the tools or capability to support innovation consistently, or the lack of a systematic architecture to support innovation.¹⁵⁷ Previous reviews have also noted the importance of ensuring the NHS sees its role as a research platform, as well as a healthcare purveyor, and that the NHS workforce are 'research aware'.¹⁵⁸

Recent years have seen a number of reviews or policy developments aimed at encouraging innovation in the NHS. For example, making sure that the UK is 'an environment and infrastructure that supports pioneering researchers and clinicians to bring innovation to market earlier and more easily' was a key part of the Strategy for the Life Sciences.¹⁵⁹ The National Institute for Health Research (NIHR) has been established, with the aim of ensuring that the NHS is an international centre for research excellence and is making a difference by providing core funding for translational research that is leading to faster translation of scientific discoveries into benefits for patients.¹⁶⁰

- **R30. The NHS needs to be considered a key part of innovation frameworks within the UK, becoming an early adopter of emerging drugs and technologies, and facilitating business-university research collaborations. [Govt]**

Localism: LEPs and Growth Hubs

141. There is a growing awareness of the importance of 'place' for innovation, reflected in the introduction of LEPs, University Enterprise Zones and the focus on the Northern Powerhouse.¹⁶¹ Regions have different innovation characteristics, determined through a combination of the presence of HEIs, infrastructure quality, the level of skills available and the types of companies present. The significance of universities in supporting innovation-driven growth in their local areas has been noted previously.¹⁶² For example, there is evidence that decisions on where to locate R&D facilities in the pharmaceutical sector are influenced by the proximity of high-quality university chemistry departments.¹⁶³ Encouraging economic growth through innovation at a local level requires local institutions which are able to support innovative firms and connect these with the research base. Recognising the differences between these local areas allows policies to be developed which seek to maximise the contribution made by innovation to local economic growth.

¹⁵⁶ *NHS Chief Executive's Review of Innovation in the NHS: Summary of responses to the Call for Evidence and Ideas*, Department of Health, 2011, p6

¹⁵⁷ *NHS Chief Executive Innovation Review*, Department of Health p9

¹⁵⁸ *Summary of dinner with Dame Ann Dowling*, Academy of Medical Sciences, 2015

¹⁵⁹ *Industrial Strategy: government and industry in partnership*, HM Government, 2012, p9

¹⁶⁰ NIHR website: <http://www.nihr.ac.uk/about/mission-of-the-nihr.htm>

¹⁶¹ Also noted in the Science and Innovation Strategy: *Our plan for growth: science and innovation*, Department for Business, Innovation and Skills, 2014,

¹⁶² *Encouraging a British Invention Revolution: Sir Andrew Witty's Review of Universities and Growth*, 'The Witty Review', 2013

¹⁶³ *Geographic proximity and firm-university innovation linkages: evidence from Great Britain*, Abramovsky, L. and Simpson, H., UCL, 2008.

142. LEPs are a relatively new addition to the innovation environment. When first established, it was intended that these would empower local business and university leaders to engage directly with government and drive decisions that help local economies to grow.¹⁶⁴ LEPs are responsible for devising their own investment strategies, finding projects and funding to meet local need, and monitoring performance against those strategies.¹⁶⁵ BIS considers LEPs to be ‘key players in steering support for innovation at the local level’.¹⁶⁶ Understanding and defining what exactly that role is, however, remains a challenge. Furthermore, contributors to this review expressed scepticism and concern over whether LEPs, as currently configured, have the right skills sets, capabilities or capacity to fulfil such a role.
143. LEPs form part of a whole system of local innovation support which has developed since the abolition of the regional development agencies in England. This includes:
- LEPs.
 - University Enterprise Zones in Bradford, Nottingham, Bristol and Liverpool, ‘designed to develop stronger partnerships between universities and business’.¹⁶⁷
 - Growth Deals negotiated with each LEP ‘to provide investment in innovation and growth, based on local priorities’.¹⁶⁸
 - Launchpad funds, provided through Innovate UK, to ‘accelerate the development of technology based business clusters that have potential for further growth’ – awarded to Tech City in London, Motorsport Valley in Oxfordshire, and Digital and Creative Clyde in Glasgow.¹⁶⁹
 - The Enterprise Europe Network which is intended to improve support to innovative businesses, working closely with LEPs.¹⁷⁰

In addition to these innovation-focused schemes, there are a whole host of other business-support schemes operating through the LEP and local business support system.¹⁷¹ For example, following a pilot, Growth Hubs are being rolled out across all LEP areas.

144. Local HEIs are important partners for LEPs seeking to increase innovation within local companies. The review group heard that each of the 39 LEPs had a Vice-Chancellor or a senior Higher Education representative on its board in order to aid communication between local businesses and universities, and could contribute towards promoting business-university collaboration in a variety of ways.¹⁷² For example, LEPs can help to arrange and/or fund KTPs, work with Catapults to design support systems which match local business needs, and marshal government funding towards innovation initiatives. There are good examples of local engagement, but nationally the picture is highly variable.
145. The allocation of European Structural and Investment Funds offers a real opportunity for directing much needed resources to innovation and collaboration at a local level, not least because innovation, research and technological development have been designated as key priority areas.¹⁷³ At least £660 million (for 2014–2020) is expected to be deployed

¹⁶⁴ *Our plan for growth: science and innovation*, Department for Business, Innovation and Skills, 2014

¹⁶⁵ *Local growth white paper*, Department for Business, Innovation and Skills, 2010

¹⁶⁶ *Innovation Report 2014*, Department for Business, Innovation and Skills, 2014

¹⁶⁷ *Our plan for growth: science and innovation*, Department for Business, Innovation and Skills, 2014, p51

¹⁶⁸ *Our plan for growth: science and innovation*, Department for Business, Innovation and Skills, 2014, p51

¹⁶⁹ *Our plan for growth: science and innovation*, Department for Business, Innovation and Skills, 2014, p62

¹⁷⁰ *Our plan for growth: science and innovation*, Department for Business, Innovation and Skills, 2014, p61

¹⁷¹ There are approximately 615 schemes advertised. A list of business support schemes is available at this link:

<https://www.gov.uk/business-finance-support-finder/search>

¹⁷² *Our plan for growth: science and innovation*, Department for Business, Innovation and Skills, 2014, p12

¹⁷³ *Structural and investment fund strategies: Preliminary guidance to Local Enterprise Partnerships*, HM Government, 2013

from these funds to support innovation and LEPs have already developed plans for using this resource, adopting a 'smart specialisation' approach.^{174 175}

146. NCUB is developing an advisory hub which will 'provide LEPs with the information they need to make good investment decisions and uncover opportunities for collaboration and partnering with projects in other areas'.¹⁷⁶ However, a significant concern remains over the granularity of LEPs and their role in developing local innovation strategy. Specialisation in a field does not end at a LEP boundary and integration is required to ensure that work within a particular sector is coordinated effectively. It is vital that LEPs do not inadvertently duplicate capability elsewhere or compete with each other to the detriment of the overall benefit to the UK. Ensuring this does not happen will require intelligent national coordination, which should be led by Innovate UK. Recent work commissioned by HEFCE highlights the variability of SMEs within each LEP by number, sectoral composition, productivity and technological intensity.¹⁷⁷ Mapping activities such as these should help LEPs coordinate research and innovation activities in a way that is most beneficial to their region. Close oversight by LEPs of the local innovation geography may also provide the opportunity to take action to close any local skills gap, ensuring that firms have access to the people with the right skills to complement the growing knowledge economy.
147. In addition, there is an urgent need for identification and sharing of best practice in innovation support across the LEPs. The level of engagement by LEPs in this review was disappointing, which may be a reflection of LEP staff being overstretched and/or lacking the capacity to engage on this particular topic. Either of these explanations would provide cause for concern. Oversight of the LEPs is shared between the Department for Communities and Local Government (DCLG) and BIS. These departments need to work together to promote the sharing of good practice on innovation support amongst the LEPs, for example by development and promulgation of an 'innovation toolkit', drawing on the expertise in those LEPs with more advanced innovation capabilities as well as within Innovate UK.
148. Finally, as discussed in chapter one, there seems to be a plethora of organisations charged with providing advice to businesses, especially SMEs, at a local level. These range from the KTN to LEPs to EENs to Growth Hubs. If there is a logic behind the distribution of responsibilities across these organisations, it is not evident to the uninitiated, and the overwhelming impression is that the complexity of the landscape acts as a barrier and inhibitor for smaller businesses wishing to access support. This message came through time and time again in the course of this review. An urgent priority for government must therefore be to simplify the mechanisms for provision of support to SMEs and to ensure that the new approach is communicated clearly and consistently. Simplification of the mechanisms for SME support at a local level – as well as improved communication to SMEs about how to access this support – is urgently required. Innovate UK seems best placed to provide the leadership for this but will need to work closely with the LEPs and with support from DCLG and BIS if change is to be effected.
- **R31.** LEPs need to have a firm responsibility and a consistent blueprint for promoting business-university collaboration, including accessing EU funding to support local innovation initiatives. They also need to be resourced at a level that means they have the capability to do this. **BIS and DCLG need to set out clear guidance on supporting innovation at a local level, which Innovate UK should be actively involved in developing and communicating. [Govt/IUK]**

¹⁷⁴ *Innovation Report 2014*, Department for Business, Innovation and Skills, 2014

^{175 176} *Our plan for growth: science and innovation*, Department for Business, Innovation and Skills, 2014, p61

¹⁷⁷ *Collaboration between SMEs and universities: local population, growth and innovation metrics*, HEFCE, 2015

- **R32.** Government has an overarching coordination role to ensure that local innovation plans are aligned with national strategies and areas of local specialisation do not overlap to a detrimental degree. **Innovate UK, with support from BIS and DCLG, should be tasked with ensuring that the innovation strategies at local levels make sense nationally and that collaboration, rather than competition, between LEPs is the dominant modus operandi. [IUK/Govt]**

5. Conclusion

149. There are many successful examples of research collaborations between business and academia in the UK, and many strengths in the existing system of support for business-university collaboration. As outlined earlier in this review, some companies have been active in developing research partnerships that produce exceptional research as well as business benefit. Yet, overall, performance in achieving such collaborations is patchy, meaning that the UK is potentially missing out on both the new research insights and the productivity benefits that collaboration can bring.
150. Furthermore, many of these collaborations remain at the level of discrete projects, rather than long-term partnerships. One area in which there is therefore potential to unlock real benefits as a result of further funding is in helping collaborations to grow to critical mass. At present, there is a gap in provision in terms of support to grow collaborations from discrete projects involving individual researchers to group-level activity. Further funding to give pump-priming support and signal the importance of collaboration could help address business needs whilst also generating new knowledge through high-quality fundamental research.
151. People are at the heart of collaboration. Personal relationships, based on trust and mutual understanding, form the foundation of successful partnerships between businesses and universities. Policy interventions in and of themselves do not create trust. It is developed when people work across institutional boundaries, understand each other's motivations and are able to see common goals. Policy interventions can support this by encouraging movement of people between business and academia, and providing incentives which help both partners see the value in working together. With that in mind, it is vital that the people who are able to cross this bridge are appropriately valued by both business and academia. Institutional incentives need to encourage such mobility, whilst also valuing the collaborative work being done at the interfaces between organisations. This requires resources, in terms of both time and money, to be available from businesses and universities to support collaboration.
152. Business-university collaboration is part of a complex innovation system. Policy interventions in this field need to take into account a wide range of actors and a plethora of schemes, which interact with each other in different ways according to who is seeking to collaborate with whom and in what sector. This complexity acts as a barrier to engagement, makes it difficult to assess policy effectiveness and risks limiting the overall efficiency of the system. Calls for simplification of the system abound. There are, broadly-speaking, two approaches to simplification: reducing the overall number of schemes, or simplifying the interface between user and scheme. Government should make every effort to ensure that it invokes both of these approaches to better effect.
153. The UK has many of the component parts necessary for successful collaboration; government now needs to ensure that these work as an effective system.

Glossary

AHRC	Arts and Humanities Research Council (AHRC): the main Research Council for arts and humanities.
AMS	Academy of Medical Sciences: the UK's national academy for medical sciences.
BA	British Academy: the UK's national academy for humanities and social sciences.
BBSRC	Biotechnology and Biological Sciences Research Council (BBSRC): the main Research Council for biotechnology and biosciences.
CASE	Studentships to support postgraduate student placements in businesses (formerly Collaborative Awards in Science and Engineering).
Catalyst	Catalysts are a form of R&D funding which focus on specific priority subject areas.
Catapult	Catapults are physical centres where businesses, scientists and engineers are co-located and work on late-stage R&D.
CDT	Centre for Doctoral Training (CDT): Research Council-supported centres for supporting postgraduate training.
Collaborative R&D awards	Collaborative R&D funding is aimed at solving specific technical or societal challenges.
_connect	_connect is an Innovate UK-backed network for industry to develop open innovation projects.
Connected	A programme supported by DELNI to connect businesses with the Northern Ireland universities and further education colleges.
CST	Council for Science and Technology (CST): committee which advises the Prime Minister on science and technology issues.
DELNI	Department for Employment and Learning Northern Ireland (DELNI): a devolved department responsible for employment and learning.
DTP	Doctoral Training Partnerships (DTPs) are block grants made by Research Councils to research organisations to support postgraduate studentships and training.
EEN	Enterprise Europe Network (EEN): an EU-wide business network.
Eight Great Technologies	Areas which have been identified by government as being potentially high growth for the UK.
EngD	The Engineering Doctorate scheme: a four-year programme of PhD research combined with time in a company.
EPSRC	Engineering and Physical Sciences Research Council (EPSRC): the main Research Council for engineering and the physical sciences.
ERDF	European Regional Development Fund (ERDF): an EU structural fund awarded to public, private and third sector organisations to support local economic growth.
ESIF	EU Structural and Investment Funds (ESIF): the EU's primary funding stream in support of economic growth and job creation.
ESRC	Economic and Social Research Council (ESRC): the main Research Council for economic and social research.
FDI	Foreign Direct Investment (FDI): an investment to acquire a management interest in a company or entity based in a country other than the investor.

Feasibility study funds	Feasibility study awards provide up to £400,000 to test a business idea.
Gateway to Research	Online database of publicly-funded research.
Growth Deals	Government funding for LEPs or local bodies to support their local economy.
GVA	Gross Value Added.
HEFCE	The Higher Education Funding Council for England (HEFCE) funds and regulates universities and colleges in England.
HEFCW	Higher Education Funding Council for Wales (HEFCW): the Welsh Government-sponsored body which is responsible for funding higher education in Wales.
HEI	Higher Education Institutions.
HEIF	Higher Education Innovation Funding (HEIF) is provided by HEFCE to support knowledge transfer activity in universities in England.
Horizon 2020	The EU's primary research and innovation funding programme.
HVMC	High Value Manufacturing Catapult: a Catapult centre focusing on innovation in manufacturing.
IAA	Impact Acceleration Accounts (IAAs) are funding awards from the Research Councils to accelerate the generation of impact from university research.
ICARG	The Confederation of British Industry's Inter-Company Academic Relations Group.
Industrial Strategy	Government strategy for supporting industry, published in 2013.
Innovate UK	Government innovation agency.
Innovation Centres	Innovation Centres are Scottish Funding Council-backed centres which support innovation in priority subject areas in Scotland.
IKC	Innovation and Knowledge Centres (IKCs) are UK centres of excellence focussed on commercial uses of technologies.
Innovation Vouchers	Innovation Vouchers provide funding for businesses to access external innovation expertise.
Interface	An SFC-backed managed brokerage service to connect universities and businesses in Scotland.
IP	Intellectual Property (IP): intangible assets arising from innovations or inventions.
IPR	Intellectual Property Rights.
Knowledge transfer	The process of sharing knowledge and skills between universities and businesses.
KTG	Knowledge Transfer Grant, available from the Scottish Funding Council to support university knowledge transfer work.
KTN	The Knowledge Transfer Network (KTN) is an Innovate UK-backed network for researchers and businesses.
KTP	Knowledge Transfer Partnerships (KTPs) are awards to support a student to carry out a research project in business.
Lambert Agreement	Model contract agreements for managing IP in collaborative research, developed by government.
Launchpad	Launchpad supports companies in specific geographic clusters with commercialisation activities.

LEP	Local Enterprise Partnerships (LEPs): voluntary partnerships between local authorities and businesses, whose role is to support economic development.
MRC	Medical Research Council (MRC): the main Research Council for medical research.
NCUB	The National Centre for Universities and Business (NCUB) is a not-for-profit membership organisation which aims to develop university-business collaboration.
NERC	Natural Environment Research Council: the main Research Council for environmental research.
NESTA	An innovation charity, with a mission to help people and organisations bring great ideas to life.
NIHR	National Institute for Health Research (NIHR): the government body which promotes, develops and funds research for the NHS.
Open innovation	An approach to research which emphasises collaborating, making use of external expertise, and sharing risks/rewards.
Patent Box	Tax regime that makes provisions for intellectual property.
Praxis Unico	Technology Transfer professional network.
Pre-competitive research	Early stage research where competitors collaborate and share resources to carry out research in areas which have cross-sectoral relevance.
PSRE	Public Sector Research Establishments (PSREs) are public bodies which provide research services to government.
R&D tax credits	A form of corporation tax relief on the basis of R&D activity in a business.
RAEng	Royal Academy of Engineering: the UK's national academy for engineering.
REF	Research Excellence Framework (REF): the method by which the quality of research being carried out in a university is assessed.
Regional Growth Fund	Government funding to support private sector development across England.
Research Councils	The seven bodies which provide research funding for higher education institutions in the UK.
RCUK	Research Councils UK (RCUK): the strategic partnership organisation for the seven Research Councils.
RPIF	Research Partnership Investment Fund (also: UKRPIF): HEFCE funding available to UK universities to support investment in higher education research facilities.
RS	Royal Society: the UK's national academy of science.
RTO	Research and Technology Organisations (RTOs) are organisations which provide research, technology and innovation services.
SBRI	The Small Business Research Initiative (SBRI) offers businesses funding to develop a new product for the public sector.
Sector leadership councils	Committees co-chaired by industry leaders and government ministers to secure progress under the industrial strategy.
Smart funding	Smart provides funding for an early stage micro, small or medium-sized business (or those thinking of starting a business) to develop a new product, process or service.

SFC	Scottish Funding Council (SFC): funding body for teaching, learning and research in Scottish universities and colleges.
State Aid	Any advantaged conferred to a business on a selective basis by a national government, which gives the business an advantage over its competitors.
STFC	Science and Technology Facilities Council (STFC): the UK's funding agency for particle physics, nuclear physics and astronomy, for large scale science facilities and national laboratories.
TRL	Technology Readiness Level (TRL): a method of describing the maturity of technology.
TTO	Technology Transfer Office (TTO): an office within a university which is responsible for ensuring that research outputs are accessible to a range of external users for commercial development or further exploitation.
UEZ	University Enterprise Zones (UEZs) are a pilot programme of geographical areas where businesses and universities receive a specific government support package to encourage innovation.

Annex A: Letter from BIS Permanent Secretary



Department
for Business
Innovation & Skills

Martin Donnelly CMG
Permanent Secretary

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19 December 2014

Dear Ann

You have kindly agreed to develop advice and recommendations for BIS on how Government can support relationships between UK businesses and the UK's world-leading university researchers.

The objective is to help researchers to understand better the interests of industry. Increased collaboration linking the long-term strategic needs of UK business with our outstanding research capabilities can deliver broad based benefits. Researchers will be engaged in world-class research on identifying technologies that are really needed by industry and in understanding what constrains implementation at scale. UK business gains a competitive edge in bringing innovative products and services quickly to market.

We recognise that for companies to share their long-term industrial strategies with academic researchers requires the foundation of a trusting relationship at the level of individuals and their immediate teams.

We would like you to consider how Government can help initiate and support such relationships for a broad range of businesses of different sizes and types, and the implications of the varying characteristics of different sectors.

You should also consider how to build on the achievements of the Industrial Strategy and how the relationships that are the focus of this work can interact and be supported by other elements of the science and innovation programme.

BIS officials will discuss with you what secretariat support you will need to help co-ordinate the study. I recognise you will want to seek additional support from the Royal Academy of Engineering, and possibly from other organisations from the broader research and innovation system, and ask that you keep officials closely engaged in the study.

We would be grateful if you could report to Government following the General Election in May 2015.

MARTIN DONNELLY

Annex B: Review Group Membership

Professor Dame Ann Dowling DBE FREng FRS, President of the Royal Academy of Engineering and Professor of Mechanical Engineering, University of Cambridge

Professor Sir John Bell GBE HonFREng FRS FMedSci, Regius Professor of Medicine, University of Oxford

Professor Tim Besley CBE FBA, School Professor of Economics and Political Science, London School of Economics and Political Science

Mr Paul Clarke, Director of Technology, Ocado Ltd

Professor Richard Clegg, Managing Director, Lloyd's Register Foundation

Mr David Eyton FREng, Group Head of Technology, BP plc

Dr Phil George, Creative Director, Green Bay Media Ltd

Dr Dave Hughes, Global Head of Technology Scouting, Syngenta Ltd

Professor Graham Hutchings FRS FLSW, Professor of Physical Chemistry and Director of the Cardiff Catalysis Institute, Cardiff University

Dr Melanie Lee CBE FMedSci, Chief Scientific Officer, BTG plc

Professor John McCanny CBE FREng FRS, Director, Institute of Electronics, Communications and Information Technology, Queen's University Belfast

Professor Sir Jim McDonald FREng FRSE, Principal and Vice Chancellor, University of Strathclyde

Dr Ruth McKernan CBE, Senior Vice President, Pfizer, and Chief Scientific Officer at Neusentis¹⁷⁸

Professor Ric Parker CBE FREng, Director of Research and Technology, Rolls-Royce plc

Mr Nigel Perry FREng, Chief Executive Officer, Centre for Process Innovation

Dr Mark Taylor, Global Strategy and Research Development Director, Dyson

Professor Jeremy Watson CBE FREng, Vice-Dean of Engineering Sciences, UCL, and Chief Scientist and Engineer, BRE

Secretariat

Dr Hayaatun Sillem, Director of Programmes and Fellowship, Royal Academy of Engineering

Dr Helen Ewles, Research Policy Advisor, Royal Academy of Engineering

Jess Montgomery, Research Policy Advisor, Royal Academy of Engineering

Gavin Copeland, Department for Business, Innovation and Skills

¹⁷⁸ Dr Ruth McKernan stood down from the Dowling Review Group on 1 May 2015, when she took up her post as CEO of Innovate UK.

Annex C: Call for Evidence

Submissions of evidence addressing the following questions are invited from organisations and individuals with expertise and interest in this area:

1. What experience do you have of establishing, participating in or supporting long-term research collaborations between business and academia?
2. What are the key success factors for building productive, long-term research partnerships between business and academia and how do these vary across sectors and disciplines?
3. What barriers do individual businesses face in developing long-term research collaborations with academic partners and how can these be overcome?
4. What barriers do academics and universities face in developing long-term research collaborations with businesses and how can these be overcome?
5. How effective are current incentives, policies and funding streams for promoting this type of collaboration? How could these be improved in order to scale up the range and impact of collaborations being undertaken nationally?
6. How can progress under the Industrial Strategy be harnessed to stimulate collaboration between businesses and researchers in the UK?
7. Which models of collaboration have proved most successful for stimulating SME engagement with the research base in the UK? What additional action needs to be taken to strengthen UK performance in this area?
8. Which approaches/sectors/organisations – in the UK or internationally – would you identify as examples of good practice in business-university collaboration with the potential to be applied more widely?

Submissions should clearly state who the evidence is being submitted by and include a brief introduction about the individual or organisation. In order to be considered, submissions should be no longer than 3,000 words and need to be sent to [the Dowling Review team](#) before close of business on **Friday 6 March 2015**. The report is expected to be issued in the summer.

Annex D: Contributors

Inclusion of an organisation in the list indicates that written evidence was submitted either by the organisation listed in the form of an organisation-level response or by an individual from that organisation.

Academy of Medical Sciences
Adaptation and Resilience in the Context of Change Network (ARCC)
ADS
Aerospace Technology Institute
AGCO Ltd
AkzoNobel Ltd
Angel Investor
Aralia Systems Ltd
ARM plc
Association for Innovation, Research and Technology Organisations (AIRTO)
Association for University Research and Industry Links (AURIL)
Association of British Pharmaceutical Industry (ABPI)
Association of Engineering Doctorates (AEngD)
Aston University
AstraZeneca plc
AVID Technology Ltd
BAE Systems plc
Barnes Aerospace
BBC
BEP Surface Technologies Ltd
Bifrangi UK Ltd
Biorenewables Development Centre
Boom Cymru TV Ltd
Bournemouth University
BP plc
BRE Trust
Brunel University London
BT plc
Cambridge Consultants Ltd
Campaign for Science and Engineering (CaSE)
Cardiff University
Centre for Process Innovation (CPI)
Centrica plc
Cheshire and Warrington LEP
Cintec International Ltd
Clifford Chance LLP Ltd
Coast to Capital LEP
Cobham plc
Construction Industry Research and Information Association (CIRIA)
Council for Mathematical Sciences
Coventry University
Cranfield University
Croda International plc
Crossword Cybersecurity plc

CROWN Packaging UK plc
Cytac Engineered Materials Ltd
Data Burrowing Solutions Ltd
Dearman Ltd
Diageo plc
Digital Catapult
DuPont Teijin Films Ltd
Durham University
Dyson Technology Ltd
Edinburgh Napier University
EEF, the manufacturers' organisation
Elsevier Ltd
Engineering Professors' Council
Eni S.p.A Ltd
EPSRC Centre for Innovative Manufacturing in Continuous Manufacturing and Crystallisation (CMAC)
EPSRC Centre for Innovative Manufacturing in Intelligent Automation
EPSRC Centre for Innovative Manufacturing in Laser-based Production Processes
FlyingBinary Ltd
Foundation for Science and Technology
Fraunhofer UK
Future Cities Catapult
GE Aviation Ltd
GE UK Ltd
General Dynamics Ltd
GKN Land Systems plc
GSK Ltd
Harbro Ltd
Heads of Chemical Engineering UK (HCEUK)
Heat Trace Ltd
Heptares Therapeutics Ltd
Heriot-Watt University
High Value Manufacturing Catapult
Higher Education Funding Council for England (HEFCE)
Humber LEP
Imanova Ltd
Imperial College London
Innovate UK
IN-PART Publishing Ltd
Institute of Cancer Research (ICR)
Institute of Physics (IOP)
Institution of Chemical Engineers (IChemE)
Institution of Civil Engineers (ICE)
Institution of Engineering and Technology (IET)
Interface
International Centre for Mathematical Sciences
International Policy Dynamics Ltd
Invista Textiles (UK) Ltd
Isaac Newton Institute for Mathematical Sciences
Isis Innovation Ltd

JBA Group Ltd
Johnson Matthey plc
Knowledge Transfer Network Ltd
Koolmill Systems Ltd
Laing O'Rourke plc
Lancaster University
Levity CropScience Ltd
London South Bank University
Loughborough University
Lucideon Ltd
Major Projects Association
Mars Petcare Ltd
Mondelēz International
National Grid Electricity Transmission plc
National Nuclear Laboratory (NNL)
National Physical Laboratory (NPL)
NDE Research Association (NDEvR)
New-Food Innovation Ltd
NMI
Ocado Ltd
Offshore Renewable Energy Catapult
Optos plc
PepsiCo Ltd
PraxisUnico
Procter & Gamble Ltd
PwC Ltd
QMC Instruments Ltd
Queen's University Belfast
RepKnight Ltd
Research and Enterprise in Arts and Creative Technology Hub (REACT Hub)
Research Councils UK
Ridgeway Technology Ventures
Rolls-Royce plc
Royal Holloway, University of London
Royal Society
Royal Society of Chemistry
Royal Society of Edinburgh
RPPtv Ltd
Russell Group
Safinah Ltd
Sasol Technology UK Ltd
Satellite Applications Catapult
Scottish Funding Council
Selden Research Ltd
Sequence Ltd
SETsquared Partnership
Sevcon Ltd
Severn Trent Water plc
Smith Institute for Industrial Mathematical Sciences
Society of Biology

SP Energy Networks Ltd
SSE plc
Swindon and Wiltshire LEP
Syngenta UK Ltd
TBG Solutions Ltd
Tees Valley Unlimited LEP
Teesside University
Terma B.V. Ltd
Thales
Thames Water Ltd
The Boeing Company
The Open University
Thomas Swan & Co. Ltd
Transport iNet
Transport Systems Catapult
Turing Gateway to Mathematics
TWI Ltd
UK Bioindustry Association (BIA)
UK Innovation Research Centre
Ulster University
Unilever UK Ltd
Universities UK
University Alliance
University College London
University of Bath
University of Birmingham
University of Bristol
University of Cambridge
University of Dundee
University of Edinburgh
University of Exeter
University of Hertfordshire
University of Huddersfield
University of Leeds
University of Liverpool
University of Manchester
University of Nottingham
University of Oxford
University of Salford
University of Sheffield
University of Southampton
University of Strathclyde
University of Surrey
University of Warwick
University of the West of England
Vulpine Science and Learning
Weir Group plc
Wellcome Trust
Zettlex Ltd

Annex E: Recommendations grouped by target

For Government:

1. The UK's research and innovation support system has become excessively complex. Government and its funding agencies should seek to reduce complexity wherever possible, for example by consolidating schemes with similar aims. Where simplification is not possible, every effort should be made to 'hide the wiring' from businesses and academics seeking support.
5. There is an ongoing challenge to engage those companies that have never participated in collaborations but could profit from doing so. A campaign raising awareness of the benefits that companies have derived from university collaboration could play a helpful role in stimulating a broader base of demand.
11. The Catapult system is now an integral part of the UK's innovation landscape. To reap the benefits:
 - a. The system needs to continue to receive long-term, sustained support from government;
 - b. The metrics used to evaluate Catapults' performance should include indicators that capture the success of their engagement with universities;
 - c. Gradual growth in the number of Catapults would be beneficial, but any growth in Catapult numbers should only occur if additional funding is available and should not be at the expense of the support assigned to existing Catapults.
12. The government needs to address the issue of VAT on shared facilities as a matter of urgency.
16. Higher Education Innovation Funding (HEIF) is an important and much valued funding mechanism for supporting universities' capacity to engage with businesses. Government should make a long-term commitment to maintaining a form of flexible funding for knowledge exchange as a means of stimulating translational activity and collaboration.
18. There is a need for a new public and private co-funded scheme that would provide pump-priming funds on a competitive basis to enable strong relationships between individuals in academia and industry to transition into group collaborations with critical mass, substantial industry funding and a long-term horizon. These 'Awards in Collaborative Excellence' (ACE) would make a substantive contribution to scaling up the overall collaborative effort in the UK.
20. The Intellectual Property Office (IPO) and Department for Business, Innovation and Skills should define principles for commercial use of background IP created through publicly-funded research.
24. When developing industrial strategy and other long-term sectoral strategies, government and business should consult universities as key partners. Innovation should be a core component of policies aimed at promoting productivity and competitiveness, with full consideration given to its role in different sectors.

25. Government should prioritise increasing public investment in R&D in industrial sectors of strategic importance, conditional on a commensurate increase in investment in associated activities by business. Innovate UK should be tasked with monitoring investment levels in R&D across industrial strategy sectors and managing the matched funding stream from government.
26. A commitment for a sector-wide increase in business investment in R&D and associated activities should be a qualifying condition for the admission of new sectors to the industrial strategy (subject to the government co-investment referred to in recommendation 25).
27. Much clearer guidance from HM Revenue and Customs and the Department for Business, Innovation and Skills (BIS) is needed for businesses on how they can make best use of R&D tax credits and how these interplay with State Aid restrictions.
28. Government and sector leadership councils should ensure that industrial strategy sector activities build in opportunities to support pre-competitive research on a collaborative basis.
29. Government should maximise the opportunities provided by the Small Business Research Initiative (SBRI) to foster business-university collaboration, including by facilitating the formation of new partnerships for commercial exploitation amongst potential bidders.
30. The NHS needs to be considered a key part of innovation frameworks within the UK, becoming an early adopter of emerging drugs and technologies, and facilitating business-university research collaborations.
31. BIS and the Department for Communities and Local Government (DCLG) need to set out clear guidance on supporting innovation at a local level, which Innovate UK should be actively involved in developing and communicating.
32. Innovate UK, with support from BIS and DCLG, should be tasked with ensuring that the innovation strategies at local levels make sense nationally and that collaboration, rather than competition, between Local Enterprise Partnerships (LEPs), is the dominant modus operandi

For Innovate UK:

1. The UK's research and innovation support system has become excessively complex. Government and its funding agencies should seek to reduce complexity wherever possible, for example by consolidating schemes with similar aims. Where simplification is not possible, every effort should be made to 'hide the wiring' from businesses and academics seeking support.
4. Universities must be robust in the promotion and implementation of their institutional conflict of interest policies to help protect individual researchers who receive funding from industry against personal criticisms based on misconceptions about the role of industry in this research. The wider research community, including the Research Councils and Innovate UK, needs to be more proactive in engaging with the media to discuss the significance of industry funding for academic research.

5. There is an ongoing challenge to engage those companies that have never participated in collaborations but could profit from doing so. A campaign raising awareness of the benefits that companies have derived from university collaboration could play a helpful role in stimulating a broader base of demand.
6. Innovate UK, collaborating with others as appropriate, should develop a system of peer-to-peer advice for business leaders seeking to get involved in collaborative research or innovation for the first time.
7. Funding bodies and universities should do more to promote examples of researchers who have derived particular benefit from collaborating with industry.
10. HEFCE, Innovate UK and the Research Councils are working with the National Centre for Universities and Business (NCUB) to develop an online brokerage platform. To be effective, brokerage services need to:
 - a. Include data on business-university partnerships that are funded by industry, charities or international agencies, as well as public funders such as the Research Councils and Innovate UK;
 - b. Provide information on potential sources of funding and support;
 - c. Be accessible to a non-specialist audience;
 - d. Be complemented by access to well-informed personnel;
 - e. Have a clear evaluation framework to enable assessment of whether the portal has achieved the objectives set; and
 - f. Be communicated pro-actively and energetically.
11. The Catapult system is now an integral part of the UK's innovation landscape. To reap the benefits:
 - a. The system needs to continue to receive long-term, sustained support from government;
 - b. The metrics used to evaluate Catapults' performance should include indicators that capture the success of their engagement with universities;
 - c. Gradual growth in the number of Catapults would be beneficial, but any growth in Catapult numbers should only occur if additional funding is available and should not be at the expense of the support assigned to existing Catapults.
13. The Research Councils and Innovate UK should build in sufficient time in their advertisement of calls for proposals where industry may be a partner in order to ensure that all companies who wish to participate have reasonable opportunity to do so and there is time for new research partnerships between businesses and universities to be put together.
14. Knowledge Transfer Partnerships (KTPs) have proved to be highly valuable for facilitating knowledge transfer and seeding collaborations. Innovate UK should increase levels of KTP funding to enable it to better meet demand for the scheme, as well as ensuring that the burden on applicants is proportionate to the size of the grant.
18. There is a need for a new public and private co-funded scheme that would provide pump-priming funds on a competitive basis to enable strong relationships between individuals in academia and industry to transition into group collaborations with critical mass, substantial industry funding and a long-term horizon. These 'Awards in Collaborative Excellence' (ACE) would make a substantive contribution to scaling up the overall collaborative effort in the UK.

21. The Research Councils and Innovate UK should build on their own successful experiences and invoke template agreements wherever appropriate.
22. Innovate UK, in consultation with the IPO, should explore the establishment of an independent source of advice and expertise that SMEs could call upon for support in negotiating contracts with universities.
23. There is scope for all parties, including the Research Councils, Innovate UK, funding councils, universities, businesses and organisations which represent TTOs, to promote examples of better practice in relation to IP and contracts and facilitate their utilisation across the community.
25. Government should prioritise increasing public investment in R&D in industrial sectors of strategic importance, conditional on a commensurate increase in investment in associated activities by business. Innovate UK should be tasked with monitoring investment levels in R&D across industrial strategy sectors and managing the matched funding stream from government.
31. BIS and the Department for Communities and Local Government (DCLG) need to set out clear guidance on supporting innovation at a local level, which Innovate UK should be actively involved in developing and communicating.
32. Innovate UK, with support from BIS and DCLG, should be tasked with ensuring that the innovation strategies at local levels make sense nationally and that collaboration, rather than competition, between Local Enterprise Partnerships (LEPs), is the dominant *modus operandi*

For Research Councils:

1. The UK's research and innovation support system has become excessively complex. Government and its funding agencies should seek to reduce complexity wherever possible, for example by consolidating schemes with similar aims. Where simplification is not possible, every effort should be made to 'hide the wiring' from businesses and academics seeking support.
4. Universities must be robust in the promotion and implementation of their institutional conflict of interest policies to help protect individual researchers who receive funding from industry against personal criticisms based on misconceptions about the role of industry in this research. The wider research community, including the Research Councils and Innovate UK, needs to be more proactive in engaging with the media to discuss the significance of industry funding for academic research.
7. Funding bodies and universities should do more to promote examples of researchers who have derived particular benefit from collaborating with industry.
8. For academics in relevant disciplines, spending time in industry should be seen as a mark of esteem that enriches their career, analogous to gaining international experience. Universities and research institutions should expect newly appointed Principal Investigators in such disciplines to gain industrial experience (if they do not already have any), and funding agencies should ensure that grant conditions encourage this.

9. Forming connections with business at the outset of an academic career path could significantly enhance the environment for collaboration over the longer-term. To enhance doctoral training:
 - a. Universities should ensure that all PhD students in appropriate subjects receive IP awareness and wider business skills training;
 - b. The Research Councils and other major funders of PhD studentships should support students in appropriate subjects to spend some time in business as part of their doctoral training; and
 - c. Universities should play an active role in facilitating industrial placements for their PhD students.
10. HEFCE, Innovate UK and the Research Councils are working with the National Centre for Universities and Business (NCUB) to develop an online brokerage platform. To be effective, brokerage services need to:
 - a. Include data on business-university partnerships that are funded by industry, charities or international agencies, as well as public funders such as the Research Councils and Innovate UK;
 - b. Provide information on potential sources of funding and support;
 - c. Be accessible to a non-specialist audience;
 - d. Be complemented by access to well-informed personnel;
 - e. Have a clear evaluation framework to enable assessment of whether the portal has achieved the objectives set; and
 - f. Be communicated pro-actively and energetically.
13. The Research Councils and Innovate UK should build in sufficient time in their advertisement of calls for proposals where industry may be a partner in order to ensure that all companies who wish to participate have reasonable opportunity to do so and there is time for new research partnerships between businesses and universities to be put together.
15. CASE studentships are highly valued tools for establishing partnerships between industry and academia. The Research Councils should: use a standard model for allocation of and eligibility for CASE studentships and synchronise timelines wherever possible; and increase the availability of CASE studentships to SMEs and to new business-university partnerships.
17. Impact Acceleration Accounts (IAAs) have also proved effective and should be offered across all the Research Councils. The approach to allocating or applying for IAAs should be common across the Research Councils.
18. There is a need for a new public and private co-funded scheme that would provide pump-priming funds on a competitive basis to enable strong relationships between individuals in academia and industry to transition into group collaborations with critical mass, substantial industry funding and a long-term horizon. These 'Awards in Collaborative Excellence' (ACE) would make a substantive contribution to scaling up the overall collaborative effort in the UK.
21. The Research Councils and Innovate UK should build on their own successful experiences and invoke template agreements wherever appropriate.
23. There is scope for all parties, including the Research Councils, Innovate UK, funding councils, universities, businesses and organisations which represent TTOs, to promote examples of better practice in relation to IP and contracts and facilitate their utilisation across the community.

For Funding Councils:

1. The UK's research and innovation support system has become excessively complex. Government and its funding agencies should seek to reduce complexity wherever possible, for example by consolidating schemes with similar aims. Where simplification is not possible, every effort should be made to 'hide the wiring' from businesses and academics seeking support.
2. The evidence so far is that the inclusion of Impact in the REF has helped to stimulate a more positive attitude amongst academics towards collaboration with business. Successor exercises to the REF 2014 should:
 - a. Maintain or increase the weighting given to Impact;
 - b. Provide more explicit recognition for staff who have moved between industry and academia in either direction, or 'discipline-hopped'; and
 - c. Consider universities' industrial collaborations, including the exchange of people and the success of their translation activities, as an important part of the 'Environment' component. [FCs]
7. Funding bodies and universities should do more to promote examples of researchers who have derived particular benefit from collaborating with industry.
10. HEFCE, Innovate UK and the Research Councils are working with the National Centre for Universities and Business (NCUB) to develop an online brokerage platform. To be effective, brokerage services need to:
 - a. Include data on business-university partnerships that are funded by industry, charities or international agencies, as well as public funders such as the Research Councils and Innovate UK;
 - b. Provide information on potential sources of funding and support;
 - c. Be accessible to a non-specialist audience;
 - d. Be complemented by access to well-informed personnel;
 - e. Have a clear evaluation framework to enable assessment of whether the portal has achieved the objectives set; and
 - f. Be communicated pro-actively and energetically.
16. Higher Education Innovation Funding (HEIF) is an important and much valued funding mechanism for supporting universities' capacity to engage with businesses. Government should make a long-term commitment to maintaining a form of flexible funding for knowledge exchange as a means of stimulating translational activity and collaboration.
23. There is scope for all parties, including the Research Councils, Innovate UK, funding councils, universities, businesses and organisations which represent TTOs, to promote examples of better practice in relation to IP and contracts and facilitate their utilisation across the community.

For Universities:

3. The perception that collaborating with industry, or spending time in industry, is damaging to an academic career path persists and detracts from the attractiveness of such activities for academics. Universities need to ensure that recruitment and promotion criteria for relevant disciplines reward rather than penalise academics who have achieved excellence in translational and collaborative activities, and that these messages are communicated effectively.

4. Universities must be robust in the promotion and implementation of their institutional conflict of interest policies to help protect individual researchers who receive funding from industry against personal criticisms based on misconceptions about the role of industry in this research. The wider research community, including the Research Councils and Innovate UK, needs to be more proactive in engaging with the media to discuss the significance of industry funding for academic research.
7. Funding bodies and universities should do more to promote examples of researchers who have derived particular benefit from collaborating with industry.
8. For academics in relevant disciplines, spending time in industry should be seen as a mark of esteem that enriches their career, analogous to gaining international experience. Universities and research institutions should expect newly appointed Principal Investigators in such disciplines to gain industrial experience (if they do not already have any), and funding agencies should ensure that grant conditions encourage this.
9. Forming connections with business at the outset of an academic career path could significantly enhance the environment for collaboration over the longer-term. To enhance doctoral training:
 - a. Universities should ensure that all PhD students in appropriate subjects receive IP awareness and wider business skills training;
 - b. The Research Councils and other major funders of PhD studentships should support students in appropriate subjects to spend some time in business as part of their doctoral training; and
 - c. Universities should play an active role in facilitating industrial placements for their PhD students.
19. University Technology Transfer Offices (TTOs) are important players in the collaboration process. In order to strengthen the role that they play:
 - a. Universities should ensure that the overarching metric used to assess the success of TTOs is their effectiveness in supporting translational activities over the longer term, not short-term revenue generation.
 - b. Universities that are confident of the performance of their TTO in supporting the establishment of collaborations should publicise statistics that highlight their efficiency and effectiveness.
 - c. TTOs and universities should work collaboratively, across institutional boundaries, to share expertise, sector knowledge and best practice.
23. There is scope for all parties, including the Research Councils, Innovate UK, funding councils, universities, businesses and organisations which represent TTOs, to promote examples of better practice in relation to IP and contracts and facilitate their utilisation across the community.

For Businesses:

23. There is scope for all parties, including the Research Councils, Innovate UK, funding councils, universities, businesses and organisations which represent TTOs, to promote examples of better practice in relation to IP and contracts and facilitate their utilisation across the community.
24. When developing industrial strategy and other long-term sectoral strategies, government and business should consult universities as key partners. Innovation should be a core component of policies aimed at promoting productivity and competitiveness, with full consideration given to its role in different sectors.

25. Government should prioritise increasing public investment in R&D in industrial sectors of strategic importance, conditional on a commensurate increase in investment in associated activities by business. Innovate UK should be tasked with monitoring investment levels in R&D across industrial strategy sectors and managing the matched funding stream from government.
26. A commitment for a sector-wide increase in business investment in R&D and associated activities should be a qualifying condition for the admission of new sectors to the industrial strategy (subject to the government co-investment referred to in recommendation 25).
28. Government and sector leadership councils should ensure that industrial strategy sector activities build in opportunities to support pre-competitive research on a collaborative basis.

For IPO:

20. The Intellectual Property Office (IPO) and Department for Business, Innovation and Skills should define principles for commercial use of background IP created through publicly-funded research.
22. Innovate UK, in consultation with the IPO, should explore the establishment of an independent source of advice and expertise that SMEs could call upon for support in negotiating contracts with universities.

For TTOs

19. University Technology Transfer Offices (TTOs) are important players in the collaboration process. In order to strengthen the role that they play:
 - a. Universities should ensure that the overarching metric used to assess the success of TTOs is their effectiveness in supporting translational activities over the longer term, not short-term revenue generation.
 - b. Universities that are confident of the performance of their TTO in supporting the establishment of collaborations should publicise statistics that highlight their efficiency and effectiveness.
 - c. TTOs and universities should work collaboratively, across institutional boundaries, to share expertise, sector knowledge and best practice.
23. There is scope for all parties, including the Research Councils, Innovate UK, funding councils, universities, businesses and organisations which represent TTOs, to promote examples of better practice in relation to IP and contracts and facilitate their utilisation across the community.





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BIS/15/352