House of Commons

Science and Technology Committee

Managing intellectual property and technology transfer

Tenth Report of Session 2016–17

HC 755

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Science and Technology Committee

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Summary

The translation of university research into commercial success—technology transfer—is a well-researched, and well-reviewed, area. Indeed, the development of an evidence base on technology transfer has benefitted from a succession of high-profile, often Government-sponsored, reviews on how to improve collaboration between universities and business, and increase the commercialisation of academic research. Such efforts are to be commended, but successes in identifying the challenges associated with technology transfer have yet to be matched by progress in tackling the underlying problems. Instead, technology transfer has been dominated by an ongoing 'review culture' and an 'implementation deficit'.

Our inquiry appears, however, to have helped refocus the Government's attention on technology transfer and the need for action. The Industrial Strategy Green Paper describes the Government's aim to "do more to commercialise our world leading science base". This is supported by additional funding, announced during the course of our inquiry, including £120 million, over the next four years, to "incentivise university collaboration in tech transfer" as well as the establishment of a separate 'Industrial Strategy Challenge Fund' to address "Britain's historic weakness on commercialisation".

We welcome the Government's renewed emphasis on technology transfer but remain concerned that its previous efforts have disproportionately focused on the 'supply' of research by universities, rather than on the level of 'demand' from businesses. Without a healthy commercial demand for R&D, the scope for universities to engage more in technology transfer is limited. Progress on this, however, is disappointing—the overall R&D intensity of the UK business sector continues to be low compared to other OECD countries. The Industrial Strategy, combined with the Government's forthcoming reviews of R&D tax credits, the Small Business Research Initiative, and the VAT system, all present valuable opportunities for the Government to refocus its efforts on raising demand for university research, and creating the conditions that are conducive to businesses investing more in R&D.

The Government has also announced that it intends to commission research to examine "different institutions' principles and practices on commercialisation of intellectual property (IP)". The valuation of IP, and the amount of equity taken in spin out companies, are contentious issues. Some evidence indicates that technology transfer offices are prioritising short-term revenue generation and overvaluing IP, whereas others maintain that this is not common practice. Technology transfer offices are often in the middle of complex IP negotiations and are tasked with balancing competing priorities, with varying degrees of support. The Government's forthcoming research should therefore examine what skills are needed to successfully value IP, and broker negotiations, as well as how these skills may vary by sector.

We were surprised to find that engagement between Local Enterprise Partnerships (LEPs) and universities is patchy. Despite having a mandate, and funding, to promote local innovation, LEPs are currently lacking any firm obligation, or support, to connect local businesses and higher education institutions. In contrast, the four pilot 'University Enterprise Zones', established with the explicit aim of increasing interaction between universities and business, are notably missing from the Industrial Strategy Green

Paper and face uncertain future funding. The Government should use the opportunity presented by the Industrial Strategy to oblige all LEPs to work with their local universities, or else reassign a proportion of their funding sufficient to roll-out a national university enterprise zones programme.

Finally, the Government must be careful not to damage the UK's pre-eminent position in academic research in pursuit of ever-greater commercialisation. The vast majority of innovations do not begin as discoveries in academic research and the Government must be alert to, and address the needs of, the UK's broader innovation landscape.

1 Introduction

1. Technology transfer describes the movement of knowledge, or technology, from one organisation to another. In higher education institutions, it is the process of commercialising university-owned 'intellectual property' (IP), namely "creations of the mind, such as inventions, literary […] works and designs"[1] that can be protected through patents, trademarks and copyright. Commercialisation may be achieved through the licencing of IP to existing companies or through setting up new, 'spin-out' companies. To facilitate this transaction, many universities have established 'technology transfer offices' (TTOs). Though the exact remit of a TTO varies between universities, they are generally responsible for identifying, protecting and transferring knowledge created in universities "out to business where it can be developed into products and services that benefit society".[2]

2. Despite being in widespread usage, the term technology transfer has been criticised for implying that innovation is a linear process that begins in universities and ends with a commercialised product. Evidence heard by our predecessor Committee during its *Bridging the Valley of Death* inquiry in 2013 highlighted that very few innovations start as discoveries in academic research.[3] The Higher Education Funding Council for England (HEFCE) told our predecessors that:

> The vast majority of new technologies in the world that become commercially adopted will be devised and developed in the business world, by entrepreneurs, technology consultants, large and small businesses and in supply chains (albeit, we believe, infused and informed by university ideas and human capital development) […] we estimate that only 19% of patent application filings from [the] UK [originate in] universities.[4]

3. While technology transfer is likely to be a more complex, interactive, and iterative process than the term implies, successive Governments and universities have increasingly focused their efforts on improving the translation of university research into commercial success. Three months after launching our inquiry, for example, in October 2016, the Chancellor announced funding of:

> £120 million [over the next four years] to incentivise university collaboration in tech transfer and in engaging with business, helping transform research at universities and institutions into viable business ventures.[5]

The following month the Government announced the establishment of the 'Industrial Strategy Challenge Fund' to "address Britain's historic weakness on commercialisation and [turn] our world-leading research into long-term success".[6] While further details are

1 World Intellectual Property Organization, What is Intellectual Property?
2 Brady, C et al, *UK University Technology Transfer: behind the headlines. A note from the UK's leading university technology transfer professionals*, April 2015
3 Science and Technology Committee, Eighth Report of Session 2012–13, Bridging the valley of death: improving the commercialisation of research, HC 348
4 Science and Technology Committee, Eighth Report of Session 2012–13, Bridging the valley of death: improving the commercialisation of research, HC 348, Ev 140, para 27
5 "£220 million for cutting-edge new technology", HM Treasury and Department for Business, Energy & Industrial Strategy news story, 1 October 2016
6 CBI annual conference 2016: Prime Minister's speech, 21 November 2016

expected shortly, the Government has stated that it will "consult on how the fund can best support emerging fields […] and other areas where the UK has a proven scientific strength and there is a significant economic opportunity for commercialisation".[7]

4. In addition to providing funding for technology transfer, the Government is also in the process of restructuring the governance of research and innovation through the *Higher Education and Research Bill* and the establishment of UK Research and Innovation (UKRI—a move we examined in detail in an earlier report *Setting up UK Research & Innovation*).[8] By establishing UKRI—which comprises the seven research councils, Innovate UK and Research England—the Government anticipates that businesses will be given "a much clearer understanding of the opportunities" available from the "intellectual property […] being generated […] in our research community".[9] Furthermore, it is hoped that "proximity and cross-fertilisation between the SMEs that use Innovate UK's services [and] the academic community […] will stimulate more commercialisation".[10]

5. Over the last 15 years, there has also been a succession of high-profile, often Government-sponsored, reviews examining the relationships between business and universities. Dame Ann Dowling's report on *Business-University Research Collaborations*, published in July 2015, identified 12 such reviews, including her own.[11] The sheer volume of work on this area, however, does not appear to have swept away the barriers to technology transfer. This became particularly apparent early in 2016 when we held a short inquiry to examine research and innovation in graphene. That inquiry raised general issues about the role of universities in the commercialisation of research, many of which went beyond the specific case of graphene (see Annex). As the Nobel Prize-winning physicist, Sir Andre Geim, explained:

> Historically, universities have two major remits: one is education and the other is bringing basic knowledge […] Now we have a new situation where universities are going from asking questions to being held responsible for commercialisation, which has never previously been a remit of universities. There is nothing wrong with that. As universities we are publicly funded organisations, and of course it is Government and the taxpayer who own the remit of the universities, but because it is a recent situation this remit is neither adequately funded nor does it even have a legal basis.[12]

Our inquiry

6. We decided to look more closely at what has been described as the 'third function' or 'third stream' of universities and, in July 2016, we launched a separate inquiry to examine how higher education institutions manage intellectual property and technology transfer. Written submissions were sought addressing the following points:

7 "PM announces major research boost to make Britain the go-to place for innovators and investors", Prime Minister's Office and Department for Business, Energy & Industrial Strategy Press release, 21 November 2016

8 Science and Technology Committee, Eighth Report of Session 2016–17, Setting up UK Research & Innovation, HC 671

9 Q289

10 ibid

11 The Dowling Review of Business-University Research Collaborations, July 2015, p11

12 Oral evidence taken on 26 April 2016 HC (2016–17) 960, Q69 [Sir Andre Geim]

- How the respective roles of universities and TTOs in commercialising research have developed over the last decade;
- How well universities and TTOs balance objectives of protecting IP and encouraging public-benefit research, and whether TTOs' and universities' IP strategies effectively deliver such objectives in practice;
- Any scope for individual universities/TTOs to adopt particular good practices and IP strategies from others:
- Whether funding arrangements for research commercialisation by TTOs are adequate and whether they facilitate an appropriate balance of objectives and an appropriate balance between short-term and longer-term aims;
- Whether SMEs and larger businesses are both given an equitable access to commercialisation opportunities;
- What measures universities, business leaders and Government should take to assist the commercialisation process, and to reach a common understanding of how the different stakeholders involved can engage in the process.

7. We received 39 submissions and took oral evidence from 19 witnesses including:

- professionals working in university technology transfer offices;
- entrepreneurs;
- businesses and trade associations;
- legal and finance professionals;
- the Royal Academy of Engineering;
- officials from the Department of Business, Energy and Industrial Strategy and Intellectual Property Office;
- the Government, represented by Jo Johnson MP, Minister of State for Universities, Science, Research and Innovation.

We would like to thank everyone who contributed to the inquiry.

8. We recognise that there has been a strong 'review culture' in the field of technology transfer and business-university collaboration. We welcome, and broadly support, the recommendations made in Dame Ann Dowling's comprehensive review of *Business-University Research Collaborations* and do not seek to rehearse all of those recommendations in this report. Rather, in light of the developing Industrial Strategy, and the establishment of the Industrial Strategy Challenge Fund, we have instead identified three aspects of the problem that need to be prioritised, and urgently addressed, through the new Industrial Strategy. Chapter 2 therefore considers how business demand for technology transfer might be increased while Chapter 3 focuses on the geographical context in which technology transfer occurs. Chapter 4 looks at funding and support for commercialising research, with conclusions drawn in Chapter 5.

2 Stimulating demand for technology transfer

9. During the course of our inquiry into graphene, we heard that both large companies and SMEs were keen to work with the National Graphene Institute (NGI) and develop commercially viable applications of the material (see Annex). Sir Andre Geim from the University of Manchester recalled that:

> Five years ago, I got an inquiry every day from companies about what they could do with graphene and whether we could help. Fortunately, now all those inquiries end up at the NGI. I heard that there are 900 every year, so there are about four inquiries per day from companies.[13]

Contributors to our technology transfer inquiry stressed, however, that this level of demand from business to collaborate with a university was not typical. This Chapter considers current levels of investment in R&D by UK business and how this may be increased.

Research intensity of British business

10. Cambridge Enterprise (the TTO of the University of Cambridge) identified a general "lack of demand from businesses both small and large for commercialisation opportunities".[14] This, they told us, reflected the findings of the "Lambert Review of Business–University Collaboration", published in 2003, which concluded that the:

> biggest challenge identified in this Review lies on the demand side. Compared with other countries, British business is not research intensive, and its record of investment in R&D in recent years has been unimpressive. UK business research is concentrated in a narrow range of industrial sectors, and in a small number of large companies. All this helps to explain the productivity gap between the UK and other comparable economies.[15]

11. According to Sir Richard Lambert's review, the key question was "how to raise the overall level of demand by business for research from all sources" and thereby increase the scope for technology transfer.[16] This point was reiterated 10 years later by our predecessor Committee in its 2013 report, *Bridging the Valley of Death*, which recommended that "the Government's objective should be to create a commercial demand for university engagement to which they are already primed to respond".[17] Cambridge Enterprise noted, however, that the Government's response to date had predominately focused on universities and the supply side of the equation. It stressed that "until the demand side is addressed the commercialisation challenge will remain for universities".[18]

13 Oral evidence taken on 26 April 2016 HC (2016–17) 960, Q69 [Sir Andre Geim]
14 Cambridge Enterprise (MIP0029) para 48
15 Cambridge Enterprise (MIP0029) para 49.1
16 HM Treasury, The Lambert Review of Business-University Collaboration, December 2003, p3
17 Science and Technology Committee, Eighth Report of Session 2012–13, Bridging the valley of death: improving the commercialisation of research, HC 348, para 127
18 Cambridge Enterprise (MIP0029) para 52

12. Dr Tony Raven from Cambridge Enterprise told us that the research intensity of British business had changed for the better in the intervening period but "not radically".[19] Expenditure on R&D by UK businesses reached £20.9 billion in 2015, the highest level since records began.[20] Yet, when placed in an international context, the "R&D intensity of the [UK] business sector continues to be low" compared to other OECD countries.[21] OECD figures from 2015 showed that while UK business was spending 1.12% of GDP on R&D, the OECD average was 1.65%, with Germany spending 1.95% and South Korea 3.28%.[22] Measures of innovation output—namely the proportion of companies introducing new, or significantly improved, goods and services—also showed a decline from 24% to 18% between 2008 and 2012 before rising to 19% in 2015.[23]

13. Dr Claire Brady from the University of Edinburgh's technology transfer office, however, was careful to distinguish between sectors, rather than treat 'business' as a homogenous group. According to Dr Brady, "demand depends a lot on company pipelines and company need" and was "different across sectors and across different sizes of companies".[24] She held up the pharmaceutical industry, and its ongoing collaborations with universities, as a positive case in point.[25] Professor Trevor McMillan, who recently authored a report on 'Good practice in Technology Transfer' for HEFCE, also identified 'sectoral variations' in technology transfer as something that required more thought and understanding by TTOs.[26]

14. Jo Johnson MP, the Minister responsible for universities, science, research and innovation, was clear that the UK had "a strong innovation ecosystem", noting that the country was ranked "very high on the global innovation scorecard" and that "pound per pound [the UK does] very well in terms of exploiting opportunities for innovation".[27] He agreed, however, that the UK did "invest less in terms of what our business community is doing" and that this had "been a consistent feature of our industrial landscape relative to other developed economies".[28] The Government's Industrial Strategy Green Paper subsequently announced that it would be exploring how the additional £4.7 billion of research funding by 2020–21 could be best used, alongside the tax environment for R&D, "to drive up the level of private investment in science, research and innovation across the economy".[29]

19 Q17
20 Office for National Statistics , Statistical bulletin: Business enterprise research and development, UK: 2015, November 2016
21 OECD Science, Technology and Industry Scoreboard 2015, United Kingdom Highlights, October 2015
22 OECD, Main Science and Technology Indicators, BERD as a percentage of GDP
23 Department for Business, Energy and Industrial Strategy, The UK Innovation Survey 2015 Main Report, Innovation Analysis, July 2016, p 11; see also Barnett, A et al, *The UK productivity puzzle*, Bank of England Quarterly Bulletin, 2014 Q2, p 122
24 Q18 [Dr Brady]
25 Q18 [Dr Brady]
26 Professor Trevor McMillan (MIP0005)
27 Q319
28 Q281
29 HM Government, *Building Our Industrial Strategy*, Green Paper, January 2017, p 29

15. **Successful technology transfer does not begin and end with universities; business also has a vital part to play. Yet, compared to our OECD counterparts, the research intensity of UK business is low. Without a healthy commercial demand for R&D, the scope for universities to engage more in technology transfer will be limited. Responsibility for remedying this problem does not rest solely with the Government, but it should be leading the way by creating conditions that are conducive to businesses investing more in R&D. To date, however, the Government's efforts to increase technology transfer have been disproportionately targeted at the university, rather than business, sector.**

16. ***The lack of progress forces us to reiterate the recommendation made in our 2013 report, namely for the Government to "create a commercial demand for university engagement to which they are already primed to respond". Facilitating greater investment in UK R&D by British business should be a key goal of the Government's Industrial Strategy.***

17. The remainder of this chapter considers how business demand for R&D could be further encouraged and incentivised.

R&D Tax Credits

18. Our witnesses identified R&D tax credits as an important tool that could "stimulate and incentivise spending on R&D".[30] Established in 2000, they allow companies to reduce their tax bill or claim payable cash credits for a proportion of their R&D expenditure. Claims have grown 35 fold since their introduction: the Government highlighted that businesses "benefit from tax credits of £1.75 billion in 2013–14 compared with £70 million in 2000–01"[31] and had risen to £2.45 billion in 2015–16.[32] Whilst welcoming R&D tax credits, witnesses stressed that the both the eligibility criteria and claims process were complex.

19. Dr Toby Basey-Fisher from Eva Diagnostics described how his company "had to move to a specialist [accountancy] firm just to get the R&D tax credits" since his original "accountancy firm did not understand it".[33] Part of the challenge, according to Dr Phil Clare from Praxis Unico, was that R&D tax credits were:

> inevitably a complicated accounting activity that requires detailed assessment on whether something fits in the box or not […] If, for example, you were able to say that any R&D spend in a university was eligible for an R&D tax credit, it would be very clear, simple and easy for us to promote and explain to our partners that if they spend money with us they get a benefit.[34]

20. Innovate UK also stressed that "tax credits do not encourage R&D specifically in collaboration with universities". They suggested addressing this through "the development of separate schemes focussing on business-university collaboration or investments

30 Q78 [Dr Clare]; see also Innovate UK (MIP0006) para 33; Q141
31 Department for Business, Energy and Industrial Strategy (MIP0011) para 28
32 Q281
33 Q78 [Dr Basey-Fisher]
34 Q78 [Dr Clare]

in companies based on UK university IP".[35] There are currently two R&D tax credits schemes; one for SMEs and the other for large companies. Felicity Burch from the CBI recommended "supercharging small companies' R and D tax credits, to make them even more of a boost to companies' cash flow" and "enabling companies to access that money on a quarterly rather than an annual basis [to] give them cash back a little more quickly".[36] We made a similar point in our *Science Budget* report in 2015.[37] The Minister, however, described the R&D tax credit system as "generous and increasingly popular", though noted that the Chancellor had announced at the 2016 Autumn Statement "a review of the R&D tax environment for business to look at whether it was as competitive as it needs to be".[38]

21. ***We recommend that the Government's review of R&D tax credits should carefully consider how the qualification and claims process for both the SME, and large company, schemes could be simplified so that they explicitly support business R&D in collaboration with higher education institutions.***

Small business research initiative

22. A review of the Small Business Research Initiative (SBRI), led by the Cambridge entrepreneur Dr David Connell, was announced by the Government at the same time as the R&D tax credits review. According to the Minister, the SBRI helps "small businesses take advantage of procurement contracts that Government are offering so that they can offer their services in an innovative way".[39] The SBRI is a:

> two stage, contract-based programme to fund the development of innovative technology solutions to meet government needs—either for departments' own requirements or to meet policy challenges. Phase 1 contacts are typically worth £50–100,000 and Phase 2 £250,000 to £1 million. Project costs are 100% funded.[40]

23. Commenting on the review, the Prime Minister was enthusiastic about the Government's capacity to "step up to help drive innovative procurement, particularly from small businesses".[41] She also highlighted how effective this approach had been in the United States, under its Small Business Innovation Research (SBIR) initiative. Unlike the UK, the SBIR in the United States has a sister programme—Small Business Technology Transfer (STTR)—which has a requirement for "the small business to formally collaborate with a research institution".[42]

24. The Dowling Review similarly singled out the UK's SBRI scheme as an important mechanism for encouraging collaboration and engaging small businesses. Dame Ann Dowling told us that the SBRI represented a "huge opportunity to use Government

35 Innovate UK (MIP0006) para 33
36 Q113 [Felicity Burch]
37 Science and Technology Committee, First Report of Session 2015–16, The Science Budget, HC 340, para 80
38 Q281
39 Q282
40 David Connell, Review of Small Business Research Initiative (SBRI), Innovate UK blog, 16 December 2016
41 CBI annual conference 2016: Prime Minister's speech, 21 November 2016
42 "About STTR", last accessed on 1 March 2017 at http://www.sbir.gov/about/about-sttr

procurement to help SMEs" and "join up academics with small companies around a new product".[43] To date, however, the UK's scheme has lagged behind its US counterpart. In *Budget 2013*, the Government announced that it would:

> substantially expand SBRI among key departments so that the value of contracts through this route increases from £40 million in 2012–13 to over £100 million in 2013–14 and over £200 million in 2014–15.[44]

But, according to the Dowling Review, the SBRI had:

> 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.[45]

25. In December 2016, David Connell confirmed that the 2014–15 target of £200 million had also not been met.[46] Figures given to us by the Minister indicated that the value of contracts awarded had, in fact, decreased. According to the Minister, the SBRI "currently provides around £63 million of contracts a year to businesses", approximately £15.5 million less than was awarded in 2013–14.[47] Dr Connell also noted that there were "many [Government] departments that don't use SBRI at all".[48]

26. **Government procurement via the Small Business Research Initiative (SBRI) is a valuable means through which to stimulate innovation, especially among SMEs. The SBRI, however, has consistently underperformed against the Government's own targets and has yet to reach its full potential.** ***We recommend that the current review of the SBRI consider what mechanisms could be put in place to encourage small businesses to collaborate with research institutions as part of the SBRI scheme.***

Online brokerage platforms

27. Some SMEs told us during our graphene inquiry that they found it difficult to access graphene commercialisation opportunities and engage with the National Graphene Institute, though other SMEs had different experiences (see Annex).[49] In our technology transfer inquiry, we heard that both SMEs and larger businesses were generally given equitable access to commercialisation opportunities, but that larger businesses tended to be more readily able to take advantage of those opportunities. As the Academy of Medical Sciences explained:

> SMEs are often focused on managing the immediate pressures of day-to-day operations, which means they may struggle to find the spare capacity to engage with universities to investigate potential licensing and collaborative opportunities.[50]

43 Q250
44 HM Treasury, Budget 2013, March 2013, HC 1033, para 1.146
45 The Dowling Review of Business-University Research Collaborations, July 2015, para 168
46 David Connell, Review of Small Business Research Initiative (SBRI), Innovate UK blog, 16 December 2016
47 Q308
48 David Connell, Review of Small Business Research Initiative (SBRI), Innovate UK blog, 16 December 2016
49 Oral evidence taken on 26 April 2016 HC (2016–17) 960, Q20 [Dr Cox]
50 Academy of Medical Sciences (MIP0012) para 6.1

Similarly, Imperial Innovations suggested that larger organisations were "more likely to employ staff whose role is to discover new technologies and have more resources to engage".[51] Navigating the plethora of organisations involved in technology transfer was also singled out as a barrier to collaborating with universities for SMEs. The Government recognised that it was hard for:

> SMEs with limited resources to navigate so many institutions and ideas and it is hard for universities to engage a myriad of smaller commercial partners.[52]

28. To make it easier for all businesses to identify potential academic partners, and understand where academic capabilities lie, the National Centre for Universities and Business (NCUB)[53] worked with the Higher Education Funding Council for England (HEFCE), Innovate UK and the research councils to develop an 'online brokerage platform'. Dr Rosa Fernández from the NCUB explained that the system, called 'Konfer', helped to identify potential research partners and was a "match.com-type" of platform:

> Konfer rarely will give you a one to one [match]. We are normally trying to describe Konfer as saying that it will give one, two or three potential dates, but you still have to go to the date and find out whether you want to go with one another. It is unlikely at this stage that Konfer will give you the person you will marry; it will give you a few possible candidates.[54]

29. Universities UK thought that Konfer would "help make collaboration opportunities more visible to businesses of all sizes".[55] Knowledge of the platform—the pilot version of which was rolled out in 2016—was, however, patchy among some of our witnesses. Dr Will West from the BioIndustry Association told us that "very few people in industry know about [brokerage platforms]", and that he had first heard about Konfer following our evidence session with the NCUB.[56]

30. Others questioned whether an online brokerage platform alone was sufficient to bring businesses and academics together. According to IN-PART (a business aimed at building university-industry collaborations):

> most R&D companies do not have a dedicated technology scouting or open innovation team going out looking for opportunities. This means people from that company are very unlikely to go to a university website or passive platform to look at what they have to offer. Ultimately this means that direct approaches are required.[57]

Many witnesses described identifying potential collaboration partners as a "contact sport" that relied on networking and face-to-face interactions.[58] What was needed, according to Professor Trevor McMillan from Keele University, was:

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51 Imperial Innovations Group plc (MIP0020) para 8.1
52 Department for Business, Energy and Industrial Strategy (MIP0011) para 59
53 An independent, not for profit body, funding by the Research Councils and Innovate UK.
54 Q90
55 Universities UK (MIP0016) para 14
56 Q154 [Dr West]
57 IN-PART (MIP0032) para 4.5; see also The Dowling Review of Business-University Research Collaborations, July 2015, para 67
58 see Q262, Q268; Q134; Q70 [Dr Clare]; Q18; Q13

> people on a daily basis wandering around, talking to the academics, getting them into the right mindset and then picking up on the ideas and gems when they appear.[59]

31. **We welcome the development of 'Konfer' as a straightforward way for businesses to identify potential academic collaborators. Algorithms alone, however, will not produce productive collaborations: potential 'matches' will need to be nurtured through supportive human interventions.** ***We recommend that the Government works with the National Centre for Universities and Business to publicise the Konfer platform. A business engagement team should also be established alongside Konfer to work with businesses and help develop the potential partnerships identified by the platform.***

VAT rules

32. HEFCE's *2014–15 Higher Education–Business and Community Interaction Survey* indicated that 9% of university revenue from licensing IP to businesses came from SMEs (£13.8m out of a total IP revenue of £155m). Income from universities renting out their facilities to business, however, was more substantial, especially from SMEs, who accounted for 31% of the total income (£59m out of a total income of £191m).

33. Some witnesses suggested that further collaboration between businesses and universities was being held back by current VAT rules on income from academic buildings. Praxis Unico, the professional association for technology transfer, stated that "VAT issues" were constraining collaboration and that "VAT on academic buildings should be changed so that businesses can co-locate with universities without causing tax challenges".[60] As the Dowling Review explained:

> 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.[61]

34. In our recent inquiry *Leaving the EU: implications and opportunities for science and research*, we heard from UCL that "previous explanations for this state of affairs have been the requirements to comply with EU legislation".[62] In the 2016 Autumn Statement the Government reported that it had asked the Office for Tax Simplification (OTS) "to carry out reviews on aspects of the VAT system".[63] When we asked the Minister if he would be pushing the OTS to scrap VAT charges on buildings where academics and industry were working alongside one another, he was non-committal, stating that:

59 Q268
60 Praxis Unico (MIP0014) para 29; see also Institute of Cancer Research (MIP0018)
61 The Dowling Review of Business-University Research Collaborations, July 2015, para 78
62 Science and Technology Committee, Seventh Report of Session 2016–17, *Leaving the EU: implications and opportunities for science and research*, HC 502, para 48
63 HM Treasury, Autumn Statement 2016, Cm 9362, para 4.43

> We obviously want to ensure that we have a competitive R&D tax environment in this country that underpins the whole theme of the autumn statement, and I look forward to seeing the outcomes of the Treasury's review.[64]

35. **The UK's exit from the European Union, combined with the Office for Tax Simplification's reviews of the VAT system, present an opportunity to revise VAT rules on the income from academic buildings in a way that facilitates greater collaboration with business.** ***We encourage the Office for Tax Simplification to examine the VAT rules on shared academic buildings with business as part of its current VAT review, and consider how they could be revised to enhance collaboration opportunities.***

64 Q313

3 Regional and sectoral differences

36. The Business Secretary, the Rt Hon Greg Clark MP, has emphasised the importance of 'place-based' innovation in relation to the Industrial Strategy. In a speech in November 2016 he explained that:

> If there is a consistent theme, I think one of them is this: the connection between innovation and place […] Scientific knowledge may be universal, but its development is local […] What is needed in each place is different, and our strategy must reflect that.[65]

More recently, in its Industrial Strategy Green Paper, the Government has been clear that "regional disparities are now wider in the UK than in other western European nations" and that "the productivity gap within each region is greater than between regions".[66] We therefore examined if there was a 'place-based' element to managing IP and technology transfer, including whether a consideration of regional geographies has formed part of Government, business and university technology transfer strategies.

Sharing best practice

37. Professor Trevor McMillan's report to HEFCE in 2016, *University Knowledge Exchange (KE) Framework: good practice in technology transfer*, was clear that technology transfer policies are sensitive to the local "entrepreneurial conditions beyond the university".[67] These include the local communications infrastructure, access to venture capital, and business and legal support. His report noted, however, that there had been "relatively little discussion in the UK about [the] spatial dimensions to technology transfer".[68] Professor McMillan also stressed that while a "university's eco-system should influence its entrepreneurial policies", so too should the university's own "characteristics and circumstances".[69]

38. The evidence we have received from universities, and from the Government, broadly supported these conclusions. Universities Scotland agreed that university technology transfer strategies should be developed "in the context of research strengths, sector needs and innovation ecosystems in which the institution operates", thereby making it "important to avoid a one-size-fits-all approach" to technology transfer.[70] HEFCE told us that there was still "scope for sharing good practices" without needing a single, 'generic' approach.[71] We heard differing views, however, on how technology transfer offices should organise themselves to make this possible.

39. At present, the dominant UK model is for each university with significant technology transfer activity to have its own technology transfer office (TTO). Recognising that each TTO is differently staffed and resourced, Dr Daniel Nelki from the Wellcome Trust

65 "A place for innovation", Speech delivered at the Innovate 2016 Conference in Manchester by Rt Hon Greg Clark MP, 3 November 2016
66 HM Government, *Building Our Industrial Strategy*, Green Paper, January 2017 p 14–15
67 University Knowledge Exchange (KE) Framework: good practice in technology transfer. Report to the UK higher education sector and HEFCE by the McMillan group, Sept 2016, para 6
68 ibid para 51
69 Ibid para 11
70 Universities Scotland (MIP0030)
71 Higher Education Funding Council for England (HEFCE) (MIP0007)

suggested that some smaller universities did not have "the throughput or capability to deal with technologies [or the] requisite expertise and advice that should be available".[72] He believed that establishing "some regional centres" to advise "local institutions" could prove "hugely advantageous".[73]

The SETsquared Partnership was repeatedly highlighted in our evidence as an example of technology transfer resources being effectively pooled across a wide geographical area.[74] SETsquared is a collaboration between the universities of Bath, Bristol, Exeter, Southampton and Surrey "on research commercialisation, student enterprise and business incubation".[75] Nick Sturge from the University of Bristol explained that while SETsquared is comprised of "five independent institutions with their own agendas and their own relationships with the local environment" the collaboration benefitted "from a common brand" and worked by "aligning the common bits of different agendas".[76] Dr Raven from Cambridge Enterprise, on the other hand, noted that regional approaches were not always successful and cited the "i10 East of England" collaboration, where the universities were "so disparate that it did not really work despite the branding".[77]

40. Imperial Innovations thought that a sectoral, rather than regional, focus might be more beneficial on the grounds that "the approach needed to get a therapeutic drug to market is very different from that required to bootstrap a fast-moving small software business to market".[78] Professor McMillan similarly stressed that "different technology transfer sectors have different exploitation pathways" and recommended that Praxis Unico, the professional association for technology transfer, should be supported to explore "whether more could be done on good practice differentiated by specific technology sector".[79] A sectoral focus on innovation is also apparent in the Industrial Strategy Green Paper.

41. ***The lack of a 'one-size-fits-all' approach to successful technology transfer does not preclude the sharing of best practice. We recommend that UK Research and Innovation (UKRI) should, once it is established, work with Praxis Unico to develop and share best practice in identifying and nurturing opportunities for technology transfer. Guidance should be developed with the needs of smaller technology transfer offices in mind and take account of regional and sectoral differences.***

42. We discuss in Chapter 4 the separate issue of best practice in IP valuation and negotiation.

72 Q225. Kingston University, for example, told us that it did not have the throughput to justify developing expertise in-house in areas requiring specific legal expertise, such as patenting. See Kingston University (MIP0031).

73 Q225; see also Royal Society (MIP0021) para 23

74 See, for example, Cambridge Enterprise (MIP0029) para 32; Wellcome Trust (MIP0028) para 4; University of Oxford (MIP0025) para 28; Royal Academy of Engineering (MIP0023) para 4.7; Imperial Innovations (MIP0020) para 3.4; Innovate UK (MIP0006) para 20

75 Q10

76 Q10

77 Q13

78 Imperial Innovations Group plc (MIP0020) para 3.1

79 University Knowledge Exchange (KE) Framework: good practice in technology transfer. Report to the UK higher education sector and HEFCE by the McMillan group, September 2016, p 7

Science and Innovation Audits

43. In 2015, the Government announced funding for Science and Innovation Audits (SIAs) to identify regional strengths in research, innovation and infrastructure. The Minister told us that SIAs are:

> a means by which we can map where there is a capacity for excellence in parts of the country that might not immediately spring to mind, so that we can ensure that areas that can be in a position eventually to make the most of public resources get their fair crack at it.[80]

44. Universities have collaborated with local business groups to produce SIAs. The University of Sheffield described how it had worked with a local consortium comprising the Sheffield City Region and the "Lancaster area" Local Enterprise Partnership (LEP) to focus on the region's strength in high value manufacturing.[81] Similarly, the University of Edinburgh was part of a consortium of local businesses, the City of Edinburgh Council, Scottish Enterprise and Innovation Centres Scotland "working to maximise the opportunities provided by data driven innovation" through its SIA.[82]

45. The Minister concluded in November 2016 that the SIA process had "brought together business, universities, Local Enterprise Partnerships and other collaborators from across the private and public sectors".[83] Understanding the UK's research strengths could also be valuable information as the Government launches its Industrial Strategy Challenge Fund which looks "to back technologies at all stages where the UK has the potential to take an industrial lead".[84]

46. Dame Ann Dowling, however, cautioned that SIAs should not be "simply looking to see what a local area can do" but that there should be coordination with "other areas that have similar strengths rather than setting up a regional competition".[85] Professor McMillan was concerned that the SIAs were a "little backward-looking"—and were identifying where an area was already strong—"rather than forward-looking".[86] Though the SIAs do feature a 'gap analysis', the 'gaps' identified tend to relate to existing sectors and rather than addressing the development of new sectors. The need to look more to the future was emphasised by Professor Paul Nightingale from the University of Sussex when he gave evidence on the Government's Industrial Strategy Green Paper. He explained that:

> it is very difficult to predict what will be important in the future; 100 years ago we said steam engines. We need to support not just the incumbents […] We need to be driving innovation and be opening up to disruptive change.[87]

80 Q279
81 University of Sheffield (MIP0024) para 5.8
82 Department for Business, Energy and Industrial Strategy (MIP0011) para 77
83 Department for Business, Energy and Industrial Strategy, Science and Innovation Audits, Wave 1 Summary Report, November 2016, p2
84 HM Government, *Building Our Industrial Strategy*, Green Paper, January 2017, p 30
85 Q266
86 Q265–266
87 Oral evidence taken on 22 February 2017, HC (2016–17) 991, Q21 [Professor Nightingale]

47. **Science and Innovation Audits have focused on mapping the UK's existing scientific strengths. This is valuable information but the Government also needs to know where the weaknesses lie, and where innovation and technology transfer are being held back. The gap analysis to date has uncovered weaknesses within existing sectors, however, rather than identifying where new sectors need to be developed. *The Government should task UK Research and Innovation (UKRI), once established, with identifying where our research and innovation gaps lie, especially where they are holding back technology transfer, and consider how these can be addressed.***

Local Enterprise Partnerships

48. Local Enterprise Partnerships (LEPs) are collaborations between businesses and local authorities that have a mandate to promote local innovation and "deliver local growth".[88] There are 39 LEPs in England that have, in total, "been awarded £200 million through [the Government's] Growth Deals for innovation projects".[89] Some Growth Deals have directly benefitted universities and increased their capacity for technology transfer. The University of Oxford told us that through OxLEP's the Growth Deal it had "invested £750,000 in university start-ups and spin-outs to leverage £8.9m of private investment and create 45 jobs […] in knowledge intensive firms".[90]

49. The Dowling Report found, however, that while LEPs have a remit to support innovation within their area, performance to date had "been patchy" and "highly variable".[91] Though it identified "good examples of local engagement", it concluded that there was a "need to set a clear national direction and provide stronger support to enable them to fulfil this role".[92]

50. The relationship expected between LEPs and universities currently appears ill-defined. The guidance provided by the Government to LEPs when drawing up 'Strategic Economic Plans' in 2013 (which were then used to negotiate 'Growth Deals') made no reference to collaborating with universities.[93] In the written evidence we received, only two universities—Sheffield and Oxford—highlighted collaborations with their LEP.[94] The Industrial Strategy Green Paper states that the Government "will work with Local Enterprise Partnerships to review their role in delivering local growth and examine how we can spread best practice and strengthen them".[95]

51. It was noticeable, however, that neither the Green Paper, nor the Government's evidence to this inquiry, referred to the University Enterprise Zones (UEZ), a scheme that aimed to:

> encourage universities to strengthen their roles as strategic partners in local growth and stimulate development of incubator and/or grow on space for small businesses.[96]

88 HM Government, *Building Our Industrial Strategy*, Green Paper, January 2017, p125
89 Department for Business, Energy and Industrial Strategy (MIP0011) para 29
90 University of Oxford (MIP0025) para 5
91 The Dowling Review of Business-University Research Collaborations, July 2015, p 3 &para 144
92 ibid
93 HM Government, Growth Deals, Initial Guidance for Local Enterprise Partnerships, July 2013
94 University of Oxford (MIP0025) para 5; University of Sheffield (MIP0024) paras 5.7–5.8
95 HM Government, *Building Our Industrial Strategy*, Green Paper, January 2017, p125
96 Department for Business, Innovation and Skills, University Enterprise Zones Pilot Evaluation, Outline Evaluation Plan and Baseline, Produced for BIS by SQW and Cambridge Econometrics, March 2015, p11

UEZs are currently being piloted in Bradford, Nottingham, Bristol and Liverpool, with the Government providing a £15 million capital fund between 2014 and 2017.[97] The future of the UEZs once the pilot scheme funding ends in 2017 is unclear. Allan Cook, Vice President of the Royal Academy of Engineering, told us that it was "a mistake that the university enterprise zones [were] not in [the Industrial Strategy Green Paper]" adding that it was an "omission" that needed some reflection.[98]

52. **The 39 Local Enterprise Partnerships in England are potentially well placed to help connect local businesses and universities. It is therefore disappointing that they are currently lacking any firm obligation, or support, to do so. In contrast, the four University Enterprise Zones, established with the explicit aim of increasing interaction between universities and businesses in particular geographic areas, face an uncertain future.**

53. ***The Government should use the opportunity presented by the Industrial Strategy to oblige all LEPs to work with their local universities and build on the strengths of the university enterprise zones or else reassign a proportion of their funding sufficient to roll-out a national university enterprise zones programme.***

97 Department for Business, Innovation and Skills, University Enterprise Zones Pilot Evaluation, Outline Evaluation Plan and Baseline, Produced for BIS by SQW and Cambridge Econometrics, March 2015

98 Oral evidence taken on 22 February 2017, HC (2016–17) 991, Q60 [Allan Cook]

4 Finance, funding and support

54. Commercialising research, whether through the licencing of IP to existing companies or through setting up new 'spin-out' companies, requires investment and support. In many cases, such investment needs to be long-term. A study by Columbia University found that in cutting edge areas of science (eg machine learning and regenerative medicine) universities were "often filing patents that are 10 years or more ahead of industry production—hammers waiting for a nail to appear".[99] This chapter considers some of the difficulties accessing long-term finance, as well as other support that is essential to foster technology transfer.

Access to finance

55. Accessing finance to commercialise research can prove challenging. The 2015 *Innovation Survey*, published by the Department of Business, Energy and Industrial Strategy in July 2016, found that the 'availability of finance' was the most cited factor constraining innovation.[100] Much of the written evidence we received focused on a lack of early stage funding (known as 'seed' and 'proof of concept' funding) where ideas need capital to start turning them into a reality. The Royal Academy of Engineering stressed that:

> effective and successful research commercialisation requires sufficient and appropriate (pre-)seed stage funding, which can help to fund 'proof-of-concept' activities and bridge the 'valley of death' between the development of a prototype and a product or service that is an investable proposition.[101]

56. Imperial Innovations told us that proof of concept funding was "not as widely or consistently available as it should be", adding it was something that "must be addressed in order to further unlock the potential of TTOs to be transformative agents in the commercialisation process".[102] Similarly, Universities UK drew attention to "the long-standing dearth of early stage, proof of concept funding in the UK", and suggested that the private sector's "inability to fill this gap" was a "constrain to research translation".[103]

57. Anne Glover from Amadeus Capital Partners explained that 'proof of concept' funding needed "to be readily available very quickly to be effective" and that "more funding" would be "welcome".[104] However, it was the absence of a 'ladder of financing', and a lack of later stage funding, that Ms Glover thought was still proving problematic, four years after identifying the same problem to our predecessor Committee:

99 Orin Herskowitz and Brady Butterfield, *"Know thyself: how well do you understand your own IP strategy?"* Intellectual Asset Management, July/August 2016, p10

100 Department of Business, Energy and Industrial Strategy, The UK Innovation Survey 2015 Main report, Innovation Analysis, July 2016

101 Royal Academy of Engineering (MIP0023) para 5.1

102 Imperial Innovations Group plc (MIP0020) para 5.3

103 Universities UK (MIP0016) para 11

104 Q174 [Anne Glover]

> The positive [change] is that we have two more steps upwards. The negative one is that there is an even greater chasm at the top. The ladder is still needed […] We have to find a way to get our capital markets interested in technology companies again. There is capital in the UK. It is just not very interested in technology, at the top end in the large asset managers.[105]

58. Mike Conroy from the British Bankers Association highlighted that the funding gap was particularly apparent for "fast-growth businesses seeking venture capital of between £10 million and £25 million".[106] There was disagreement in the written evidence, however, about the availability, and overall suitability, of venture capital finance for technology transfer. The University of Sheffield saw problems with the venture capital (VC) model, stating that:

> It does not incentivise academic participation, as it is a narrow approach to the application of research […] The VC model is generally looking to spin-out or licence early-stage ideas, with a view to making the best financial return at the optimum time. One in 50 of the opportunity disclosures looks like a venture capital opportunity. One in 10 of these might get funded. One in 10 of those might succeed.[107]

Others suggested that venture capital was unsuitable for particular sectors, such as the biosciences. Cambridge Enterprise noted that VC funds typically backed "ideas over the short-term and [required] a quick exit" which, it argued, was "not particularly suited to bioscience with its long development and regulatory timeframes".[108]

59. Several steps have been taken to try to address these problems. The Wellcome Trust announced in May 2016 that, as a charity, it would use its "financial independence" and its "freedom to take on problems others would find very challenging" to work "earlier and later in the translation pathway".[109] A number of universities also highlighted that they had established their own 'in-house' investment funds known as 'patient capital', described by the Russell Group as:

> 'evergreen' funds [that] take a much longer investment time horizon than traditional venture capital companies as they do not have fixed term investment periods. Instead they reinvest any proceeds back into new start-ups and their existing portfolio of companies to make returns over longer, open-ended periods. Investors in patient capital companies are willing to forgo an immediate return in anticipation of more substantial returns further down the road.[110]

105 Q157, Q162
106 Q174 [Mike Conroy]
107 The University of Sheffield (MIP0024) para 1.8; see also Mercia Technologies PLC (MIP0002)
108 Cambridge Enterprise (MIP0029) para 8
109 Stephen Caddick, The future of innovation at the Wellcome Trust, 24 May 2016, https://blog.wellcome.ac.uk/2016/05/24/the-future-of-innovation-at-the-wellcome-trust/ last accessed 2 March 2017
110 Russell Group (MIP0009) para 4.2

60. Cambridge Enterprise, the TTO of the University of Cambridge, told us that its in-house patient capital fund—Cambridge Innovation Capital—and Imperial College's fund—Imperial Innovations—were each:

> investing at a rate of around £60m p.a. each in early stage technology companies compared with the British Venture Capital Association membership which (excluding Imperial Innovations) is only investing £48m p.a. across early stage tech and non-tech.[111]

61. Such funds, however, are not widespread. Anne Glover stated that there were "not many investors" that would support patient capital funds and that there was "a limited pool in the UK".[112] The Royal Academy of Engineering was concerned that while the recent increase in patient capital investment vehicles had "created a welcome market of investors for universities to choose from", the existence of exclusive deals—"whereby the investment vehicle has the exclusive right to commercialise all IP from a university"—can restrict "academic founders […] in the choice of initial investors for a spin-out".[113] This, in turn, can "mean a spin-out misses out on investment and support that is more appropriate for their company".[114]

62. The Minister described the development of patient capital by "some of our best-known institutions" as "hugely welcome", noting that "10 years ago this simply did not exist".[115] Highlighting the Government's forthcoming review of patient capital, announced in the 2016 Autumn Statement, the Minister told us that the challenge now was "to ensure that these pools of capital become available more broadly across our system".[116] According to the Government, the review is to be led by HM Treasury and supported by an industry panel drawn from "leading investors and entrepreneurs" and chaired by Sir Damon Buffini.[117]

63. **Difficulties accessing long-term finance have been a persistent barrier to commercialising the UK's scientific and technological breakthroughs. A handful of UK universities have been at the forefront of developing the 'patient capital' model to address this funding gap. It is therefore surprising that the terms of reference for the Government's forthcoming Patient Capital Review do not mention universities, nor is there any indication that they will have a place on the 'industry panel' that will support the review.**

64. ***The Government's Patient Capital Review must engage with the university sector and learn from those universities that have developed patient capital schemes.***

IP valuation and negotiations

65. Under UK law, notably the Patents Act 1977 and the Copyright, Designs & Patents Act 1988, IP generated in the course of a person's normal employment belongs to the

111 Cambridge Enterprise (MIP0029) para 17
112 Q187; see also The University of Sheffield (MIP0024) para 1.8
113 Royal Academy of Engineering (MIP0023) paras 5.2–5.4
114 ibid
115 Q283
116 Q283
117 Department for Business, Energy and Industrial Strategy and HM Treasury, Terms of reference for the Patient Capital Review, February 2017

substantive employing organisation.[118] Universities typically assert ownership rights to intellectual property developed using its resources, so that when efforts are made to licence its IP, or spin-out a company around it, the university would usually value the IP. Universities tend to take an equity stake in a spin-out company or royalties in licensing deals, though practices vary between institutions.

66. Reaching an agreement with academics (and investors) can involve universities in complex negotiations A survey undertaken as part of the Dowling Review found that negotiations taking "too long to complete", and processes being "difficult to navigate or taking too long", was the number one barrier to collaboration cited by businesses.[119] There have been suggestions that negotiation delays arise from technology transfer offices overvaluing IP in a bid to generate short-term income, or taking a disproportionally large equity share, though the evidence we heard did not confirm whether this was common practice. The Dowling Review identified a tension between "the desire [for universities] 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".[120] Dame Ann explained to us that:

> technology transfer offices are quite often asked to bring in enough money to pay for their running costs. If they do that, they tend to look to shorter-term licensing than spin-outs, which have a much longer time to grow.[121]

67. There was mixed evidence on whether the tension set out in the Dowling Review reflected the experiences of our other witnesses. The BioIndustry Association (BIA) noted that Dame Ann's findings "[resonated] with many BIA members"[122] and the Royal Society told us that:

> Some academics reported a sense that universities have strategic interest in pursuing one avenue for commercialisation over another, in particular to prioritise short-term revenue generation to make the TTO financially sustainable. This may make TTOs risk averse and is perceived to be a cause of the high equity shares and IP valuations that they expect.[123]

The Wellcome Trust's research into technology transfer also reported that "a pressure to create revenue can lead to overvalued IP, licencing terms that disincentivise deals, and insufficient consideration of quality measures".[124]

68. The Russell Group of universities, on the other hand, strongly disagreed:

> Any suggestion universities and TTOs are focused on short-term returns from IP is misleading […] Universities must cover the cost of the research they conduct, and it is reasonable to require payments for IP generated from

118 The legal rules of IP ownership are different for university employees and non-employees such as students, consultants, clinicians, honorary academics and employees of other bodies. See Intellectual Property Office, Intellectual Asset Management for Universities, June 2014

119 The Dowling Review of Business-University Research Collaborations, July 2015, p 27

120 The Dowling Review of Business-University Research Collaborations, July 2015, p 3

121 Q248

122 BioIndustry Association (MIP0034)

123 The Royal Society (MIP0021) para 16

124 Wellcome Trust, The UK's innovation ecosystem, Summary of a review commissioned by the Wellcome Trust, not dated

> university research in order to support further activities. This is not a form of short-term return but a fair and proportionate return on investment for the university's intellectual contribution.[125]

Similarly, Dr Tony Raven from Cambridge Enterprise, the University of Cambridge's TTO, told us that:

> If we [Cambridge Enterprise] were looking for short-term income, we would do very different deals. Most of the deals we do are not a typical deal, in that we do not ask for big up fronts; we just recover our patent costs […] We are not looking to suck out short-term money.[126]

Universities UK also stressed that technology transfer was generally a cost to universities and not a source of revenue.[127]

69. Other witnesses suggested that the very nature of negotiations, together with the challenges posed by valuing new, early-stage technologies, can mean that a degree of delay and difficulty is unavoidable. As Mark Anderson from the Law Society explained, "it is a negotiation: inevitably, there are going to be difficulties sometimes".[128] Dr Toby Basey-Fisher shared his experience of spinning out his company, Eva Diagnostics, noting that the process was:

> always going to be challenging, because it involves many different stakeholders with many different views and expectations of what they want and what they would like to see happen and those coming together. It will be a difficult process.[129]

70. The Russell Group also highlighted how the:

> Valuation of IP assets can […] be extremely challenging due to market uncertainty related to early-stage university technologies, including timescales to market, investment needs and avenues to achieving commercially viable outcomes.[130]

TTOs tend to manage a "breadth of technologies and disciplines" which the Academy of Medical Science thought made it "challenging for TTO staff to acquire the in-depth knowledge […] required to fully understand commercialisation opportunities" and accurately value them.[131] Dr Raven emphasised that this was particularly "difficult and challenging for people in the smaller [TTOs]".[132]

71. Support and guidance for TTOs appears to be in short supply. According to the Royal Academy of Engineering, there are currently "limited materials" available that "provide comprehensive guidance on approaches to market assessment and opportunity

125 Russell Group (MIP0009) para 3.5
126 Q5
127 Universities UK (MIP0016) para 6, see also Praxis Unico (MIP0014) para 22 & Universities Scotland (MIP0030) para 8
128 Q201
129 Q82
130 Russell Group (MIP0009) para 3.3
131 Academy of Medical Sciences (MIP0012) para 3
132 Q62 [Dr Raven]

evaluation".[133] The Intellectual Property Office (IPO) has, however, recently updated its Lambert toolkit, which includes a 'template agreement' for handling the IP in collaborative research.[134] The Government reported that:

> research commissioned by the IPO revealed that the Lambert toolkit has been a very useful resource, reducing legal costs, resources and time in negotiating agreements between publicly-funded research organisations and industry.[135]

Cranfield University described the Lambert model agreements as "a highly effective example of a toolkit that eases collaborative university-industry engagement", while other universities thought that acceptance and take up of the agreements was relatively low.[136]

72. In its Industrial Strategy Green Paper, published in January 2017, the Government stated that it will:

> commission research on different institutions' principles and practices on commercialisation of intellectual property, including how they approach licensing intellectual property and take equity in spin-outs […] The Government will then use the findings to identify and spread best practice among universities' technology transfer offices.[137]

73. **Technology transfer offices (TTOs) should be focused on taking a long-term approach to developing IP. Some, it is claimed, look primarily for short-term revenue, though the extent to which this influences TTO practices is unclear. TTOs are often situated in the middle of complex IP negotiations, balancing competing priorities, with varying degrees of support.**

74. ***We encourage the Government to use its forthcoming research on the commercialisation of intellectual property to examine what skills are needed to successfully value IP and broker negotiations, as well as how these skills may vary by sector. The research should engage with technology transfer offices (TTOs), Innovate UK, the research councils, funding councils and sector-specific bodies. The resulting best practice guidance must be made available online to TTOs, with consideration given to disseminating the material further through training courses and through establishing a mentoring scheme.***

Higher Education Innovation Funding (HEIF)

75. The Higher Education Funding Council for England's (HEFCE) Higher Education Innovation Fund (HEIF) was repeatedly singled out by universities as an invaluable source

133 Royal Academy of Engineering (MIP0023) para 4.4

134 The Lambert toolkit aims to assist "academic or research institutions and industrial partners who wish to carry out research projects together" through providing template collaboration agreements that set out basic principles of collaboration. See https://www.gov.uk/guidance/university-and-business-collaboration-agreements-lambert-toolkit

135 Department for Business, Energy and Industrial Strategy (MIP0011) para 33; see also Q293

136 Cranfield University (MIP0015) para 6.3; see also Cambridge Enterprise (MIP0029) para 28, Imperial Innovations Group plc (MIP0020) para 3.5, Q70 [Dr Clare]

137 HM Government, *Building Our Industrial Strategy*, Green Paper, January 2017, p32

of flexible funding that had helped them to develop their technology transfer capabilities.[138] Cambridge Enterprise described HEIF as an "important funding stream for the success of technology transfer in the UK" adding that "the ring fencing of the funding for knowledge transfer and commercialisation activity is helpful to ensuring a professional and responsive service".[139] Welsh Universities, however, highlighted that there was an "absence of HEIF type monies in Wales" and that with "little or no funding […] available for TTOs", Swansea University reported that its "commercial throughput [was] severely limited by a lack of predictable funding".[140]

76. The Minister recognised that HEIF played "a crucial part in helping fund the operations of technology transfer offices in our universities" adding that the "additional £100 million", announced at the 2016 Autumn Statement "to fund collaboration between universities in support of knowledge exchange activities" would be "either very HEIF-like or extremely complementary to HEIF".[141]

77. **The Higher Education Innovation Fund (HEIF) has played a crucial role in enabling universities to develop their technology transfer capabilities. We welcome the additional £100 million investment in knowledge exchange activities by the Government and its commitment to HEIF-type funding. *Such funding should be consistently available across the United Kingdom.***

Advice and simplifying the innovation landscape

78. Academics have varying experience when it comes to negotiating commercialisation deals. Innovate UK found that first-time academic entrepreneurs "frequently confront a deal-making process they do not completely understand" and sometimes "do not fully recognise how the interests of the TTO and university may diverge from their own".[142] The Royal Society suggested that academics, at all career stages, were "likely to need support to develop business awareness before they [could] effectively engage with commercialisation activities".[143] It singled out "training, network building and mentoring" as important aspects of "developing an entrepreneur".[144]

79. We heard about several schemes that provide this type of support. Chris Mairs from Enterprise First explained that it typically spent:

> six months intensively working with the start-up, mentoring them not so much on the technology […] but on how to build a business, how to go out and raise finance, how to create contracts, how to share data with businesses and so on. It is a very full-on process.[145]

The Royal Academy of Engineering's Enterprise Fellowships also provide an "intensive bespoke package of training and mentoring" delivered by "leading engineers with first-

138 University of Oxford (MIP0025) para 8; Royal Academy of Engineering (MIP0023) para 3.5; The Royal Society (MIP0021) para 18; Imperial Innovations Group plc (MIP0020) para 2.3; The Institute of Cancer Research, London (MIP0018) para 11; Cranfield University (MIP0015) para 4.1; University College London (MIP0013) para 7
139 Cambridge Enterprise (MIP0029) para 2.5
140 Swansea University (MIP0022)
141 Q287
142 Innovate UK (MIP0006)
143 The Royal Society (MIP0021) para 21
144 ibid
145 Q195

hand experience of founding, building and leading successful engineering and technology companies".[146] When we asked one of its Enterprise Fellows, Dr Toby Basey-Fisher, what was more valuable to him—the funding or the mentoring—he replied:

> The mentoring […] For us, the biggest requirement has always come from having the right individuals who are very knowledgeable in our space to guide and help us understand how best to allocate the resource that we have been given to achieve the greatest impact for the company as a whole.[147]

80. Other witnesses emphasised that advice and mentoring were essential to help guide businesses and academic entrepreneurs through the complexity of the UK's innovation landscape. As Dr Nelki from the Wellcome Trust explained:

> I can understand why an SME, particularly without that mentorship and expert advice […] could think, "I am not even sure where to start or who I should go to in order to get further financing". There is a degree of complexity.[148]

81. The "complexity of the policy support mechanisms for research and innovation" had been singled out in the 2015 Dowling Review as posing a key "barrier to business engagement in collaborative activities, especially for small businesses".[149] It recommended that the 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.[150]

82. Dame Ann was positive about the progress made in addressing her recommendation. She noted that Innovate UK had done "much to simplify their programmes" and also highlighted Innovate UK's 'no wrong door policy':

> No matter how a business first approaches them, Innovate UK internally will do what we refer to as hide the wiring and make sure that business is guided to the right part of Innovate UK seamlessly. That is absolutely a huge step forward.[151]

83. The Royal Academy of Engineering, however, were concerned about the development of new finance products by Innovate UK. In the 2015 Spending Review, the Government announced that Innovate UK would allocate £165 million of its budget to new finance products by 2019–20. Although the precise form that the new finance products will take is yet to be decided, they will generally involve a move from grants to loans. We raised concerns about this shift in 2015 in our *Science Budget* report.[152] In this inquiry, the Royal Academy of Engineering told us that:

146 Royal Academy of Engineering (MIP0023) paras 1.2 & 4.8
147 Q77
148 Q230 [Dr Nelki]
149 The Dowling Review of Business-University Research Collaborations, July 2015, p 2
150 The Dowling Review of Business-University Research Collaborations, July 2015, para 33
151 Q244
152 Science and Technology Committee, First Report of Session 2015–16, *The science budget*, HC 340, paras 76–78

> Serious concerns exist about whether the new financial products Innovate UK are developing will be effective in stimulating and supporting early-stage, high-risk and disruptive innovation, or business-university collaboration. Furthermore, there are concerns that accepting a loan rather than a grant may make a company less attractive to downstream investors.[153]

84. Felicity Burch from the CBI expressed similar anxieties[154] while Richard North from Rolls Royce worried that:

> loans versus grants would be a big retrograde step […] A loan will be a liability on the balance sheet and it would be like any other form of company investment: whether the loan is from the Government or from a bank, it is capital that we have to pay back. It fundamentally changes the approach to investing in what are essentially high-risk, early-stage technologies.[155]

Dr Will West from the BioIndustry Association, however, thought that there might be a place for loans at certain stages of the commercialisation process. He explained that while "some of the very early-stage translational work will be difficult to do without funding it through grants […] loans could have a role in some of the later-stage translational" work.[156]

85. Witnesses also noted that Innovate UK was "underfunded relative to the rest of the science and innovation landscape".[157] Innovate UK will, however, be responsible for managing the Industrial Strategy Challenge Fund with the research councils[158] and, as part of the Industrial Strategy Green Paper, the Government is consulting on "which challenge areas" the Fund should "focus on to drive maximum economic impact".[159] At the time we concluded our inquiry, no details were available on how the fund will be disbursed and whether awards will take the form of grants or loans, and/or if funds will need to be matched by private sector investment.

86. **Efforts to simplify the innovation landscape are slowly moving in the right direction. We remain concerned, however, that while Innovate UK has streamlined its funding schemes, the proposed shift away from awarding grants, and towards loans, could undermine the progress that has been made to date.**

87. ***We recommend that the majority of the Industrial Strategy Challenge Fund should be disbursed in the form of grants. A small proportion of the Fund should be set aside to provide support for business training and mentoring, in order to maximise the success rate of the awards that are made.***

153 Royal Academy of Engineering (MIP0023) para 7.8
154 Q140 [Felicity Burch]
155 Q140 [Richard North]
156 Q140 [Dr West]
157 Q113 [Felicity Burch]; see also Q156
158 HM Treasury, Autumn Statement 2016, Cm 9362, para 3.29. It is a new cross-disciplinary fund to support collaborations between business and the UK's science base.
159 HM Government, *Building Our Industrial Strategy*, Green Paper, January 2017, p35

5 Conclusion

88. Our inquiry has highlighted the major issues on the topic of technology transfer, but it is clear that we are not the first to do so. Problems in this area, as well as potential solutions, have long been identified and understood. Indeed, the evidence base is strong and well-developed due, in no small part, to a succession of high-profile, often Government-sponsored reviews (at least 12 at the last count) reporting over the last 15 years. While successive Governments have made sustained efforts to illuminate the obstacles to research commercialisation and technology transfer, it is disappointing to see these endeavours tail off, and enthusiasm dwindle, when it comes to taking action to address these obstacles.

89. Our key finding is that successes in identifying the challenges associated with technology transfer have yet to be matched by progress in tackling the underlying problems. Instead, the 'review culture' in this field has obscured an 'implementation deficit' and a sluggish pace of change. The eighteen month delay between Dame Ann Dowling publishing her review into *Business-University Research Collaborations*, and the Government formally responding to her recommendations, is symptomatic of this inaction.

90. **The Government, has recently sent several strong signals—through the establishment of UK Research and Innovation (UKRI), the forthcoming Industrial Strategy, and the creation of the Industrial Strategy Challenge Fund—that it is serious about technology transfer. Together, these three developments present a valuable opportunity to break this cycle of reviews, and shift the Government's focus towards taking actions that will help to foster technology transfer. At the same time, the Government must be careful not to damage the UK's pre-eminent position in academic research in pursuit of ever-greater commercialisation.**

91. Finally, it is important to re-emphasise that the vast majority of innovations do not start as discoveries in academic research. While the attention on technology transfer in the Industrial Strategy Green Paper is welcome, the Government must not lose sight of the UK's broader innovation landscape. As Professor Nightingale explained:

> there is a big world of innovation out there that [the Green Paper] is not focusing on, and that needs to be addressed. If we focus only on that small bit [university research], we may distort the system and not fund and support bits of the UK innovation system that are very successful.[160]

92. ***To ensure the current momentum in advancing technology transfer is maintained, the Government should task UK Research and Innovation (UKRI) with publishing annual progress reports against the recommendations made in Dame Ann Dowling's review. Those reports should highlight what actions have been taken, and how the UK's technology transfer ecosystem is developing.***

160 Oral evidence taken on 22 February 2017, HC (2016–17) 991, Q3 [Professor Nightingale]

Conclusions and recommendations

Stimulating demand for technology transfer

1. Successful technology transfer does not begin and end with universities; business also has a vital part to play. Yet, compared to our OECD counterparts, the research intensity of UK business is low. Without a healthy commercial demand for R&D, the scope for universities to engage more in technology transfer will be limited. Responsibility for remedying this problem does not rest solely with the Government, but it should be leading the way by creating conditions that are conducive to businesses investing more in R&D. To date, however, the Government's efforts to increase technology transfer have been disproportionately targeted at the university, rather than business, sector. (Paragraph 15)

2. *The lack of progress forces us to reiterate the recommendation made in our 2013 report, namely for the Government to "create a commercial demand for university engagement to which they are already primed to respond". Facilitating greater investment in UK R&D by British business should be a key goal of the Government's Industrial Strategy.* (Paragraph 16)

3. *We recommend that the Government's review of R&D tax credits should carefully consider how the qualification and claims process for both the SME, and large company, schemes could be simplified so that they explicitly support business R&D in collaboration with higher education institutions.* (Paragraph 21)

4. Government procurement via the Small Business Research Initiative (SBRI) is a valuable means through which to stimulate innovation, especially among SMEs. The SBRI, however, has consistently underperformed against the Government's own targets and has yet to reach its full potential. *We recommend that the current review of the SBRI consider what mechanisms could be put in place to encourage small businesses to collaborate with research institutions as part of the SBRI scheme.* (Paragraph 26)

5. We welcome the development of 'Konfer' as a straightforward way for businesses to identify potential academic collaborators. Algorithms alone, however, will not produce productive collaborations: potential 'matches' will need to be nurtured through supportive human interventions. *We recommend that the Government works with the National Centre for Universities and Business to publicise the Konfer platform. A business engagement team should also be established alongside Konfer to work with businesses and help develop the potential partnerships identified by the platform.* (Paragraph 31)

6. The UK's exit from the European Union, combined with the Office for Tax Simplification's reviews of the VAT system, present an opportunity to revise VAT rules on the income from academic buildings in a way that facilitates greater collaboration with business. *We encourage the Office for Tax Simplification to examine the VAT rules on shared academic buildings with business as part of its current VAT review, and consider how they could be revised to enhance collaboration opportunities.* (Paragraph 35)

Regional and sectoral differences

7. *The lack of a 'one-size-fits-all' approach to successful technology transfer does not preclude the sharing of best practice. We recommend that UK Research and Innovation (UKRI) should, once it is established, work with Praxis Unico to develop and share best practice in identifying and nurturing opportunities for technology transfer. Guidance should be developed with the needs of smaller technology transfer offices in mind and take account of regional and sectoral differences.* (Paragraph 41)

8. Science and Innovation Audits have focused on mapping the UK's existing scientific strengths. This is valuable information but the Government also needs to know where the weaknesses lie, and where innovation and technology transfer are being held back. The gap analysis to date has uncovered weaknesses within existing sectors, however, rather than identifying where new sectors need to be developed. *The Government should task UK Research and Innovation (UKRI), once established, with identifying where our research and innovation gaps lie, especially where they are holding back technology transfer, and consider how these can be addressed.* (Paragraph 47)

9. The 39 Local Enterprise Partnerships in England are potentially well placed to help connect local businesses and universities. It is therefore disappointing that they are currently lacking any firm obligation, or support, to do so. In contrast, the four University Enterprise Zones, established with the explicit aim of increasing interaction between universities and businesses in particular geographic areas, face an uncertain future. (Paragraph 52)

10. *The Government should use the opportunity presented by the Industrial Strategy to oblige all LEPs to work with their local universities and build on the strengths of the university enterprise zones or else reassign a proportion of their funding sufficient to roll-out a national university enterprise zones programme.* (Paragraph 53)

Finance, funding and support

11. Difficulties accessing long-term finance have been a persistent barrier to commercialising the UK's scientific and technological breakthroughs. A handful of UK universities have been at the forefront of developing the 'patient capital' model to address this funding gap. It is therefore surprising that the terms of reference for the Government's forthcoming Patient Capital Review do not mention universities, nor is there any indication that they will have a place on the 'industry panel' that will support the review. (Paragraph 63)

12. *The Government's Patient Capital Review must engage with the university sector and learn from those universities that have developed patient capital schemes.* (Paragraph 64)

13. Technology transfer offices (TTOs) should be focused on taking a long-term approach to developing IP. Some, it is claimed, look primarily for short-term revenue, though the extent to which this influences TTO practices is unclear. TTOs are often situated in the middle of complex IP negotiations, balancing competing priorities, with varying degrees of support. (Paragraph 73)

14. *We encourage the Government to use its forthcoming research on the commercialisation of intellectual property to examine what skills are needed to successfully value IP and broker negotiations, as well as how these skills may vary by sector. The research should engage with technology transfer offices (TTOs), Innovate UK, the research councils, funding councils and sector-specific bodies. The resulting best practice guidance must be made available online to TTOs, with consideration given to disseminating the material further through training courses and through establishing a mentoring scheme.* (Paragraph 74)

15. The Higher Education Innovation Fund (HEIF) has played a crucial role in enabling universities to develop their technology transfer capabilities. We welcome the additional £100 million investment in knowledge exchange activities by the Government and its commitment to HEIF-type funding. *Such funding should be consistently available across the United Kingdom.* (Paragraph 77)

16. Efforts to simplify the innovation landscape are slowly moving in the right direction. We remain concerned, however, that while Innovate UK has streamlined its funding schemes, the proposed shift away from awarding grants, and towards loans, could undermine the progress that has been made to date. (Paragraph 86)

17. *We recommend that the majority of the Industrial Strategy Challenge Fund should be disbursed in the form of grants. A small proportion of the Fund should be set aside to provide support for business training and mentoring, in order to maximise the success rate of the awards that are made.* (Paragraph 87)

Conclusion

18. The Government, has recently sent several strong signals—through the establishment of UK Research and Innovation (UKRI), the forthcoming Industrial Strategy, and the creation of the Industrial Strategy Challenge Fund—that it is serious about technology transfer. Together, these three developments present a valuable opportunity to break this cycle of reviews, and shift the Government's focus towards taking actions that will help to foster technology transfer. At the same time, the Government must be careful not to damage the UK's pre-eminent position in academic research in pursuit of ever-greater commercialisation. (Paragraph 90)

19. *To ensure the current momentum in advancing technology transfer is maintained, the Government should task UK Research and Innovation (UKRI) with publishing annual progress reports against the recommendations made in Dame Ann Dowling's review. Those reports should highlight what actions have been taken, and how the UK's technology transfer ecosystem is developing.* (Paragraph 92)

Annex: Graphene research and innovation

1. In March 2016, members of the Committee[161] visited the National Graphene Institute (NGI) at the University of Manchester, the national centre for graphene research in the UK, which was officially opened by the then Chancellor of the Exchequer in March 2015. Graphene, a one atom thick form of carbon, has great but still uncharted potential—it is one hundred times stronger than steel and conducts electricity better than copper. We discussed the NGI's work with the University of Manchester vice-chancellor and others and saw the NGI laboratories.

2. In March 2016 media reports appeared which alleged that some academics had concerns about the NGI's safeguards on its research and that its intellectual property was being inappropriately used by a company with Taiwanese links (though UK-registered)—BGT Materials—and Chinese universities.[162]

3. We decided to examine the state of research and innovation of graphene, as well as the media allegations about the University's intellectual property management. We took oral evidence from Sir Andre Geim, one of the discoverers of graphene, the University, businesses involved in commercialising graphene, Innovate UK and Baroness Neville-Rolfe, then minister for intellectual property.[163] We also received written evidence from these witnesses and from others.[164]

Graphene research and its commercialisation

4. The University of Manchester highlighted the extent of the likely growth in the global market for 'graphene materials'—from $20 million in 2014 to more than $390 million in 2024, and "much higher" for 'graphene-enabled products'.[165] Sir Andre Geim described graphene as "a revolution in terms of new materials", and explained that "the superlatives that the material has attracted—the strongest, the thinnest, the most conductive, the most pliable and so on—definitely indicate that there are many possibilities".[166]

5. Sir Andre emphasised, however, that graphene's development was still at a relatively early stage:

> What we are witnessing now is the first stage of the commercialisation of graphene. It is probably less than five years since it was demonstrated that this group of materials could be obtained in tonnes and in square kilometres. […] At the moment all applications are, frankly speaking, simple, dirty and marginal improvements, not the killer applications that everyone is talking about. This is the natural progression. Take the silicon age. It took between 20 and 40 years to study the properties of silicon in

161 Victoria Borwick MP, Stella Creasy MP and Graham Stringer MP.
162 Academics in revolt as China reaps benefits of British breakthrough', Sunday Times, 13 March 2016
163 Oral evidence taken on 26 April 2016, HC (2015–16) 960, and on 13 September 2016, HC (2016–17) 159
164 Science and Technology Committee, Graphene inquiry (references to the inquiry's written evidence are labelled with a 'GRA' prefix).
165 University of Manchester (GRA0012); IDTechEx, *Graphene Markets, Technologies and Opportunities 2014–2024* (May 2014)
166 Oral evidence taken on 26 April 2016, HC (2015–16) 960, Q63

> terms of fundamental research and applications. Then some very obscure applications came about, first ugly transistors, then simplistic circuits and so on. It took 50 to 60 years before we got our shiny iPhones.[167]

6. That shaped the role of the University in facilitating graphene's development. Sir Andre Geim told us:

> I see the relationship between the University and collaborating companies as a way to stimulate graphene developments for the good of UK plc rather than for profit. If and when the companies start generating profits, the University will of course benefit through shareholding and patents. But this is secondary. […] I only wish someone would use our IP or patents, but it is still too early at this stage of graphene development. The Institute's involvement has been to provide expertise in graphene, which allows companies including BGT Materials to avoid silly mistakes. […] This is the Institute's most important function for the moment.[168]

7. The Government has invested more than £120 million "in graphene research, training and development".[169] Last month it announced further funding grants for the Sir Henry Royce Institute for Advanced Materials at Manchester, which undertakes graphene research.[170]

8. The University of Manchester told us that it had "a strategy of pursuing strategic partnerships, promoting inter-disciplinarity and understanding partners' needs" and that:

> This has been reflected in our approach to graphene where partnerships may be strategic or on a project basis. There are three kinds of projects: Those which are completely new […], those which rely on existing industry with a strong presence in the UK […] and those which rely on existing industry which does not have a strong presence in the UK.[171]

9. Some of our witness were uncertain about the NGI's role. Tim Harper thought it was unclear whether its role was "purely for academic research or whether it is supposed to also lead to the commercialisation of graphene"[172]. He thought the line between the two was "fuzzy".[173] Others—Ray Gibbs of Haydale Graphene Industries, Dr Liam Britnell from BGT Materials and Harry Swan of Thomas Swan & Company—did not share that uncertainty.[174]

10. The NGI's focus, the University of Manchester told us, was on "academic-led research ('Technology Readiness Levels' 1–5) into graphene/related 2-D materials in collaboration with industry". Its work involved the "demonstration of new concepts, new applications and fundamental studies, and establishing the potential of graphene by producing new

167 Oral evidence taken on 26 April 2016, HC (2015–16) 960, Q63
168 'Sir Andre Geim: response to Sunday Times', Manchester university website, 16 March 2016
169 BIS (GRA020); Oral evidence taken on 26 April 2016, HC (2015–16) 960, Q64
170 HM Government, '*£229 million of industrial strategy investment in science, research and innovation*', Gov.uk press release (23 February 2017)
171 University of Manchester (GRA0012)
172 Tim Harper (GRA0006)
173 Oral evidence taken on 26 April 2016, HC (2015–16) 960, Qq24–25
174 Oral evidence taken on 26 April 2016, HC (2015–16) 960, Qq25–27

concept products and processes".[175] The Centre for Process Innovation, part of the High Value Manufacturing Catapult, believed that the UK spent more on graphene research than on application and manufacturing. They told us that "it may be that competitors are deploying more of their resources on the exploitation of graphene technology".[176]

11. The Graphene Engineering Innovation Centre, due to open in 2018, is designed to help such technology exploitation. The University of Manchester explained that while the NGI was under construction it became evident that "its effectiveness would be substantially enhanced by creating a further institution to […] provide convincing demonstrations of next-generation products and processes in a way that de-risked them for industry." This, they told us, "underpinned the rationale for setting up the Graphene Engineering Innovation Centre", which will focus on industry led technology development (Technology Readiness Levels 3–6).[177] Professor Luke Georghiou, Vice-President for Research and Innovation at the University of Manchester, also explained that the NGI (unlike the Graphene Engineering Innovation Centre) was "a research place" and therefore not liable to VAT.[178]

Access for SMEs

12. One of the issues raised in the media reports last year was that SMEs were finding it difficult to get access to the NGI. Dr Nigel Salter of 2-D Tech, a graphene SME, told us that his company's relationship with the University was "generally poor: There was a culture of competition and mutual distrust between the University academics and 2-D Tech".[179] He wanted to see universities adopting longer term strategies for sharing intellectual property with SMEs:

> Universities tend to aim to establish a portfolio of patents that they then endeavour to licence for short-term return or use as a basis for spin-out companies. Both of these routes tend to preclude the possibility of working with existing SMEs who can take on the seed-stage ideas and provide a commercial platform. Universities should consider the option of retaining ownership of patents, but giving access to SMEs to develop the technology and accepting that any returns may be many years away. […] In the current febrile world of graphene patents, there is much to be said for universities holding ownership, providing they adopt practical and long term strategies for sharing with SMEs, many of whom will not persist.[180]

13. Dr Erik Cox and his company, Inclusive Designs Ltd, complained that the NGI resisted meeting them, citing "possible confidentiality issues with other projects".[181] Tim Harper, a nanotechnology entrepreneur, similarly criticised the NGI for "choosing to partner chiefly with large multinational corporations".[182] Some SMEs complained that fees charged by the University for exploratory engagement presented a problem for them.[183]

175 University of Manchester (GRA0012)
176 Centre for Process Innovation (GRA0008)
177 University of Manchester (GRA0012)
178 Oral evidence taken on 26 April 2016, HC (2015–16) 960, Q91
179 Dr Nigel Salter (GRA0011)
180 Dr Nigel Salter (GRA0011)
181 Inclusive Designs Ltd (GRA0005); Oral evidence taken on 26 April 2016, HC (2015–16) 960, Qq4, 9, 20
182 Tim Harper (GRA0006); Oral evidence taken on 26 April 2016, HC (2015–16) 960, Q20
183 Oral evidence taken on 26 April 2016, HC (2015–16) 960, Qq61–62

14. Others were positive about their relationship with the NGI and the University, including three of our witnesses—Ray Gibbs (Haydale Graphene Industries),[184] Dr Liam Britnell (BGT Materials)[185] and Harry Swan (Thomas Swan & Company).[186]

15. Innovate UK emphasised that "most UK SMEs are focused on 'up stream' processes for graphene related technology; that is, manufacture of graphene itself, or intermediate products such as inks and composites, rather than final end-products such as light bulbs or structural composites.[187] The University of Manchester disputed the complaints we had received from some SMEs.[188] They told us that it was working on graphene with 69 organisations (associated with 85 projects), of which 28 were SMEs (including 20 SMEs with a UK manufacturing base).[189] They explained how their links with different types of businesses depended on the stage of maturity of the relevant technology:

> Our approach is to enter into non-exclusive arrangements to optimise opportunities for collaboration and commercial returns. IP is made available on appropriate terms to secure collaborative arrangements with business for the NGI, given that our strategy envisaged that 'first' significant commercialisation is likely to be achieved through such engagement with established companies […]. 'Second' and 'third' phases will be achieved through our own spin-outs led by respected entrepreneurs and engineering-savvy CEOs, and student start-ups, and then ultimately licensing activities. This would be expected at the point when the market (for angel and venture capital investment and stand-alone licensing) begins to mature.[190]

16. The University told us that it had 'project partners' which included major global companies as well as "several SMEs". It also had two 'strategic partners'—Morgan Advanced Materials and BGT Materials—which brought "the kind of product engineering and design expertise necessary for commercialising 2D materials, which is in short supply in the UK".[191] Professor Georghiou explained that "we find it easier to work with established companies. That is not necessarily a statement about size; we include SMEs in the term "established companies", but they have to have a sufficiently developed infrastructure and employ people who are able to use the relevant science", and that the University required payment for its substantive contacts with businesses because of a universities-wide requirement to "work at cost".[192]

IP management and patents

17. Worldwide, the number of graphene-related patent applications rose to over 9,000 in 2014 from 1,000 in 2010, according to the UK Intellectual Property Office, with most

184 Oral evidence taken on 26 April 2016, HC (2015–16) 960, Q8
185 Oral evidence taken on 26 April 2016, HC (2015–16) 960, Qq8, 16
186 Oral evidence taken on 26 April 2016, HC (2015–16) 960, Q18
187 Innovate UK (GRA0015)
188 A group of SMEs raised concerns, and the University of Manchester responded, in successive submissions: Tim Harper (GRA022), University of Manchester (GRA0026), Manchester Graphene Technologies Ltd (GRA0027), University of Manchester (MIP0027), Brian McCann, Tim Harper and Alex Stewart (MIP0033), and University of Manchester (MIP0035).
189 Oral evidence taken on 26 April 2016, HC (2015–16) 960, Q66; University of Manchester (GRA0012) updated by (MIP0035)
190 University of Manchester (GRA0012
191 University of Manchester (GRA0012)
192 Oral evidence taken on 26 April 2016, HC (2015–16) 960, Q75

submitted by China. The Centre for Process Innovation, part of High Value Manufacturing Catapult, noted that in some countries there is a culture that promotes the filing of patent applications, but that many of these would never be granted. The Centre for Process Innovation highlighted that producers and users of new materials, such as graphene, develop intellectual property through the accumulation of know-how, and that "in many early-stage organisations […] retaining internal know-how is often of greater value than patents".[193]

18. Innovate UK explained the limitations of patenting and of the number of patents as a measure of innovation:

> There are numerous approaches to the commercialisation of intellectual property, from practising in secret at one end, to patent filing to establish a monopoly position at the other. Companies often combine different approaches and patents are also filed to put the innovation into the public domain to prevent someone else from making a claim to that particular invention. It is important to understand that a patent is a small part of the commercialisation process. On their own patents generate relatively little value. […] Simply counting the number of patents produced within a region or country is a poor measure of innovation, especially with some companies engaged in 'patent thicket' strategies.[194]

19. In a similar vein, Dr Nigel Salter, the managing director of 2-D Tech, a graphene SME, told us:

> Patents come in many flavours and some are worth more than others. The objective should be to identify a market and a technological solution and then protect this combination … Of themselves, many early-stage conceptual patents have little worth, and can become barriers to partnerships, shared endeavour and meaningful communication. They are important, but are a means to an end and not an end in themselves. […] In the graphene world there is a tendency to patent at a very early stage and well before the scope, the value and the technology is suitably mature. […] Researchers are keen to patent their ideas, often for personal reputational reasons, and to keep the know-how to themselves. This inhibits critical review from an application or market perspective. It also wastes time and money and can inhibit effective commercialisation.[195]

20. Dr Nigel Salter, the managing director of 2-D Tech, was concerned about academic staff being directors of BGT Materials because, he believed, it "inhibited open discussion […] with other companies".[196] The University of Manchester signed a research collaboration agreement with BGT Materials—one of the NGI's two 'strategic partners' (Annex, paragraph 16)—in October 2013 and has a 17.5% shareholding in the company. Professor Georghiou emphasised that "it is absolutely the norm: We have a number of academics who sit on the board, never in an executive position".[197] He explained that "if

193 Centre for Process Innovation (GRA0008)
194 Innovate UK (GRA0015)
195 Dr Nigel Salter (GRA0011); See also Oral evidence taken on 26 April 2016, HC (2015–16) 960, Q46 [Dr Erik Cox] and Q54 [Ray Gibbs]
196 Dr Nigel Salter (GRA0011)
197 Oral evidence taken on 26 April 2016, HC (2015–16) 960, Q87

there is a partnership with a business in a particular area and our researchers are working with one company, we cannot then work with another company in an area very close to that: It would not matter if the incumbent was a large firm or a small firm."[198]

21. BGT Materials similarly refuted last year's media reports (Annex, paragraph 2) alleging that it enjoyed inappropriately favoured access to graphene intellectual property or that confidential information was being shared with Chinese universities and businesses. BGT Materials told us that non-disclosure agreements had been "respected".[199] The University of Manchester refuted the claims about academics "boycotting" the NGI and insisted that there was no evidence of BGT Materials having access to confidential research programmes or of poor safeguards on the University's intellectual property. Sir Andre Geim described the allegations as "ridiculous".[200]

22. Professor Georghiou explained that the University developed intellectual property in collaboration with companies, which would have "the full rights, usually by their sector", but that the University would retain the right to use it in further research and to apply it in other sectors.[201] When it came to graphene, the University explained that:

> The initial method of isolating graphene could not sensibly be patented as this was not a commercial process and applications were not then known. The sole effect at that time would have been to restrict others from experimenting on the material, which is counter to the University's ethos. […] The number of patents filed or published has been cited as a measure of research and commercial activity, but numbers do not equate to quality or practically useful inventions. […] Our aim is to acquire 'enabling' IP so that it provides a broad platform for application and product opportunities for ourselves and our collaborators, as well as potentially giving us a position which will require others to seek licences from the University to operate their IP.[202]

23. Sir Andre Geim believed that "some academics publish too many patents". He explained that the cost of supporting, or defending, patents had to be taken into account:

> I have 10 patents or so at the moment for very specific applications that are defensible […] You have to think about the cost of patents. Each patent costs £50,000 to support over its lifetime […] Patents are a very inaccurate and artificial measure of success […] We are not behind; we are more selective in publishing […] If you asked me how many of those 10 patents I should have had, I would probably say three or four. I doubt that six of those are really going to play anyway […] Patents are a defensive mechanism to defend your commercial product. Universities by definition do not produce commercial products.[203]

198 Oral evidence taken on 26 April 2016, HC (2015–16) 960, Q76
199 Oral evidence taken on 26 April 2016, HC (2015–16) 960, Qq29–31, 33–34, 36, 39
200 Oral evidence taken on 26 April 2016, HC (2015–16) 960, Q69
201 Oral evidence taken on 26 April 2016, HC (2015–16) 960, Q96
202 University of Manchester (GRA0012)
203 Oral evidence taken on 26 April 2016, HC (2015–16) 960, Qq101–102

The University of Manchester's projections were that over the next five years the cost of securing and defending its patents in 'graphene/2-D' materials would be £750,000 a year.[204] They told us that:

> As collaborations and general activity increases, when the NGI comes fully online, patent and related costs will likely go higher. These costs have been met from our own resources and from our Higher Education Innovation Fund allocation.[205]

Tim Harper, a nanotechnology entrepreneur, believed that "most [university] Technology Transfer Offices struggle to cover the costs of evaluating, protecting and licencing intellectual property".[206]

24. The University told us that it had had an external review of its "graphene activities and arrangements" in 2012 which had "supported our approach". Subsequently, they told us, "an independent audit of our graphene IP strategy and practice, led by the then President of the Chartered Patent Agents' Society, in June 2014 fully endorsed our practices with some recommendations for improvements".[207]

Standards

25. As an evolving technology, the issue of what constitutes graphene has become more important. Innovate UK pointed out that "there is no 'standard' form of graphene and the end product varies from company to company".[208] Innovate UK highlighted that "characterising the material requires specialist equipment that is usually out of reach for small companies" and that as a result there was some evidence that "variability in the quality of graphene supplied from sources (particularly outside the UK) is affecting the development of high performance downstream products".[209] Xefro Club, which represents a group of dissatisfied customers of a business selling 'graphene radiators', told of about their dangerous experiences.[210] The Financial Conduct Authority has warned about scams where consumers are targeted by companies offering unregulated investments in graphene.[211]

26. As Professor Georghiou of University of Manchester put it, "you need standards to eliminate […] the bottom-feeders who pretend they have graphene when they do not".[212] The University emphasised that:

> The commercialisation of graphene […] requires a fit-for-purpose standards regime. Measurement standards are needed to allow the accurate, precise and rapid characterisation of these new materials, and hence assess any safety issues. Without them, market confidence is undermined, as users cannot compare different commercial materials or develop application areas without first understanding how changes in their material ultimately

204 Oral evidence taken on 26 April 2016, HC (2015–16) 960, Q105; University of Manchester (GRA0012)
205 University of Manchester (GRA0012)
206 Tim Harper (GRA0006)
207 University of Manchester (GRA0012)
208 Innovate UK (GRA0015); See also oral evidence taken on 26 April 2016, HC (2015–16) 960, Q55
209 Innovate UK (GRA0015)
210 Xefro Club (GRA0019). See also response Tim Harper (GRA0023).
211 *Graphene investment schemes*, Financial Conduct Authority website
212 Oral evidence taken on 26 April 2016, HC (2015–16) 960, Q72

> affects their product. The market needs to 'trust' what it is getting. […] To address this deficit, the NGI and the National Physical Laboratory […] are addressing the perceived metrology and standardisation gap in commercialisation.[213]

Wider issues

27. Our visit to the NGI and our short inquiry on graphene highlighted wider issues about the way universities more generally manage the intellectual property of their research programmes and engage in technology transfer. In July 2016 we launched such a wider inquiry. This Annex, describing our graphene scrutiny, forms part of the report on that inquiry.

213 University of Manchester (GRA0012), paras 15, 22–23; National Physical Laboratory (GRA0007)

Formal Minutes

Wednesday 8 March 2017

Members present:

Stephen Metcalfe, in the Chair

Victoria Borwick	Derek Thomas
Dr Tania Mathias	Matt Warman

Draft Report (*Managing intellectual property and technology transfer*), proposed by the Chair, brought up and read.

Ordered, That the draft Report be read a second time, paragraph by paragraph.

Paragraphs 1 to 92 read and agreed to.

Annex and Summary agreed to.

Resolved, That the Report be the Tenth Report of the Committee to the House.

Ordered, That the Chair make the Report to the House.

Ordered, That embargoed copies of the Report be made available, in accordance with the provisions of Standing Order No. 134.

[Adjourned till Wednesday 15 March at 9.30 am

Witnesses

The following witnesses gave evidence. Transcripts can be viewed on the inquiry publications page of the Committee's website.

Wednesday 2 November 2016	*Question number*
Dr Tony Raven, Chief Executive, Cambridge Enterprise, **Nick Sturge**, Director, Engine Shed, University of Bristol, and **Dr Claire Brady**, Head of Technology Transfer, Edinburgh Research and Innovation, The University of Edinburgh	Q1–67
Dr Phil Clare, Chair, Advocacy Committee, PraxisUnico, **Dr Rosa Fernández**, Research Director, National Centre for Universities and Business, and **Dr Toby Basey-Fisher**, Chief Executive, Eva Diagnostics	Q68–110

Tuesday 22 November 2016	
Dr Will West, Executive Chairman, CellCentric and Member, BioIndustry Association Board, **Felicity Burch**, Head of Innovation and Digital, CBI, and **Richard North**, Head of IP Protection Licensing and Control, Rolls-Royce	Q111–154
Anne Glover, Co-founder and Chief Executive, Amadeus Capital Partners Ltd, **Chris Mairs** CBE FREng, Venture Partner, Entrepreneur First, and **Mike Conroy**, Executive Director, Corporate and Commercial Banking, British Bankers' Association	Q155–198

Wednesday 14 December 2016	
Mark Anderson, The Law Society IP Law Committee, and **Dr Daniel Nelki**, Science to Health Lead, Wellcome Trust	Q199–241
Professor Dame Ann Dowling, President, Royal Academy of Engineering, and **Professor Trevor McMillan**, Vice-Chancellor, Keele University	Q242–272

Wednesday 11 January 2017	
Jo Johnson MP, Minister of State for Universities, Science, Research and Innovation, Department for Business, Energy and Industrial Strategy, **Jenny Dibden**, Director of Science and Research, Department for Business, Energy and Industrial Strategy, and **Sean Dennehey**, Acting Chief Executive Officer, Intellectual Property Office	Q273–323

Published written evidence

The following written evidence was received and can be viewed on the inquiry publications page of the Committee's website.

MIP numbers are generated by the evidence processing system and so may not be complete.

1 Academy of Medical Sciences (MIP0012)
2 BioIndustry Association (BIA) (MIP0034)
3 Brian McCann, Tim Harper, and Alex Stewart (MIP0033)
4 Cambridge Enterprise (MIP0029)
5 Cardiff University (MIP0010)
6 Cranfield University (MIP0015)
7 Department for Business, Energy and Industrial Strategy (MIP0011) and (MIP0040)
8 Dr Richard Worswick (MIP0008)
9 Higher Education Funding Council (HEFCE) (MIP0007)
10 Imperial College London (MIP0017)
11 Imperial Innovations Group plc (MIP0020)
12 Innovate UK (MIP0006)
13 IN-PART (MIP0032)
14 inventtory Limited (MIP0039)
15 Kingston University (MIP0031)
16 Mercia Technologies PLC (MIP0002)
17 National Centre for Universities and Business (MIP0019)
18 PraxisUnico (MIP0014)
19 Professor Trevor McMillan (MIP0005) and (MIP0038)
20 Research Councils UK (MIP0026) and (MIP0037)
21 Royal Academy of Engineering (MIP0023)
22 Russell Group (MIP0009)
23 Swansea University (MIP0022)
24 The Institute of Cancer Research, London (MIP0018)
25 The Royal Society (MIP0021)
26 The University of Birmingham (MIP0001)
27 The University of Sheffield (MIP0024)
28 Universities Allied for Essential Medicines (MIP0004)
29 Universities Scotland (MIP0030)
30 Universities UK (MIP0016)
31 University Alliance (MIP0036)
32 University College London (MIP0013)
33 University of Manchester (MIP0027) and (MIP0035)

34 University of Oxford (MIP0025)

35 Wellcome Trust (MIP0028)

List of Reports from the Committee during the current Parliament

All publications from the Committee are available on the publications page of the Committee's website.

The reference number of the Government's response to each Report is printed in brackets after the HC printing number.

Session 2016–2017

First Report	EU regulation of the life sciences	HC 158
Second Report	Digital skills crisis	HC 270 (HC 936)
Third Report	Satellites and space	HC 160 (HC 830)
Fourth Report	Forensic Science Strategy	HC 501 (HC 845)
Fifth Report	Robotics and artificial intelligence	HC 145 (HC 896)
Sixth Report	Evidence Check: Smart metering of electricity and gas	HC 161 (HC 846)
Seventh Report	Leaving the EU: implications and opportunities for science and research	HC 502 (HC 1015)
Eighth Report	Setting up UK Research & Innovation	HC 671 (HC 1063)
Ninth Report	Future programme: 'My Science Inquiry'	HC 859
First Special Report	Satellites and space: Government Response to the Committee's Third Report of Session 2016–17	HC 830
Second Special Report	Forensic Science Strategy: Government Response to the Committee's Fourth Report of Session 2016–17	HC 845
Third Special Report	Evidence Check: Smart metering of electricity and gas: Government Response to the Committee's Sixth Report of Session 2016–17	HC 846
Fourth Special Report	Digital skills crisis: Government Response to the Committee's Second Report of Session 2016–17	HC 936
Fifth Special Report	Robotics and artificial intelligence: Government Response to the Committee's Fifth Report of Session 2016–17	HC 896
Sixth Special Report	Leaving the EU: implications and opportunities for science and research: Government Response to the Committee's Seventh Report	HC 1015
Seventh Special Report	Setting up UK Research & Innovation: Government Response to the Committee's Eighth Report	HC 1063

Session 2015–2016

First Report	The science budget	HC 340 (HC 729)
Second Report	Science in emergencies: UK lessons from Ebola	HC 469 (Cm 9236)
Third Report	Investigatory Powers Bill: technology issues	HC 573 (Cm 9219)
Fourth Report	The big data dilemma	HC 468 (HC 992)
First Special Report	Royal Botanic Gardens, Kew: Government Response to the Committee's Seventh Report of Session 2014–15	HC 454
Second Special Report	Current and future uses of biometric data and technologies: Government Response to the Committee's Sixth Report of Session 2014–15	HC 455
Third Special Report	Advanced genetic techniques for crop improvement: regulation, risk and precaution: Government Response to the Committee's Fifth Report of Session 2014–15	HC 519
Fourth Special Report	The science budget: Government Response to the Committee's First Report of Session 2015–16	HC 729
Fifth Special Report	The big data dilemma: Government Response to the Committee's Fourth Report of Session 2015–16	HC 992