
Dowling Review

Institute of Physics response to
a Royal Academy of
Engineering and Department
for Business, Innovation and
Skills call for evidence

A full list of the Institute's
submissions to consultations
and inquiries can be viewed at
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11 March 2015

IOP Institute of Physics

11 March 2015

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

Dear Sir/Madam,

Submission to the Dowling Review of university-business collaboration

The Institute of Physics is a leading scientific society. We are a charitable organisation with a worldwide membership of more than 50,000, working together to advance physics education, research and application. We engage with policymakers and the general public to develop awareness and understanding of the value of physics and, through IOP Publishing, we are world leaders in professional scientific communications.

The IOP welcomes the opportunity to contribute to Prof. Dame Ann Dowling's review of business-university collaboration. Our response to the questions listed in the call for input is presented below.

Yours faithfully,

A handwritten signature in black ink, appearing to read 'Dr Frances Saunders'.

Dr Frances Saunders CB FREng CEng CPhys FInstP
President, Institute of Physics

1. What experience do you have of establishing, participating in or supporting long-term research collaborations between business and academia?

There is a long history within physics as a discipline of promoting collaboration between business and academia. There are a number of positive case studies in physics and related technologies, particularly within more established fields including nuclear physics, low-temperature physics, photonics, semiconductor physics and polymer physics, which have resulted in both high quality research outputs and also technologies and companies that have changed the world.¹

The Institute of Physics has significant experience of bringing together physicists from industry and academia to share expertise, subject knowledge and best practice in knowledge exchange. It supports around 50 subject groups to facilitate interaction and collaboration and hosts national and international conferences to further the discipline. The IOP is developing a programme of work called *Exchange* which specifically aims to stimulate research collaborations between business and academia, as well as collaborations across discipline boundaries and in new and emerging areas of discovery. This work spans open innovation, connecting large and medium sized businesses to academia, as well as business incubation support for entrepreneurial physicists looking to take ideas to market.

2. What are the key success factors for building productive, long-term research partnerships between business and academia and how do these vary across sectors and disciplines?

Long-term partnerships between business and universities have been shown to have significant benefits for the universities, the businesses, and the areas of science and technologies in which they work. Such partnerships require long-term strategic alignment from both parties, in this way they are different from, though often related to, individual collaborations on specific projects or research outputs. Because of this need for long-term commitment from both parties, the number of relationships that are truly productive partnerships is still relatively modest – in physics-related technologies, several larger companies have effectively ‘outsourced’ their longer term research to Universities and there are also examples of high tech small companies operating in distinctive niche areas which have grown up around spin-outs or licenced technologies from a University.

In practice, the truly successful partnerships between business and universities are often built on a foundation of sustained collaboration and increasing trust between organisations over many years. Very often this is achieved initially through the creation and strengthening of key, close working relationships between individuals within each organisation which then expand to become embedded organisationally. These relationships can be fostered in a number of ways, for example: through developing existing networks, conferences and events or through external and internal incentives to bring businesses and academics together. Schemes that help introduce academics to business, particularly early in their careers, can be very effective at cultivating collaborative relationships. Good examples of these include the Royal Society Industry Fellowship², CASE and iCASE (and CAST in Northern Ireland) Studentships and Funded Engineering Doctorates, as well as other secondments and internships.

¹ Institute of Physics – *Physics: transforming lives*:
http://www.iop.org/publications/iop/2013/page_60316.html

² The Royal Society – *Industry Fellowship*: <https://royalsociety.org/grants/schemes/industry-fellowship/>

The development of these key relationships helps to increase the likelihood of other success factors, in particular:

- Developing a shared understanding of opportunities and technology requirements between collaborators.
- Learning how one another's organisation operates.
- Creating the right environment and infrastructure for collaboration.

Collaborators need to have a clear understanding of the objectives, goals and expectations of one another, and how they might relate to their own aims and structures. For example in universities, it may be the research aspect and the desire to increase the performance of a technology which will dominate the interaction. For businesses, it will be looking for a productive, competitive benefit for their business, for example from that advance in technology (what this means may change depending on the size and type of business). Use of tools and techniques such as Technology Readiness Levels and Technology and Product Roadmaps for technology insertion can help collaborators create the shared ambition that meets both their needs.

Each partner organisation also needs to develop an understanding of the attitudes and working practices of the other. For example, they will need to make efforts to address and accommodate the differing timescales (in terms of outcomes, but also things like funding cycles and opportunities) associated with academic research and business-based innovation. Businesses are structured around products and markets whereas universities are structured around disciplines and faculties; structures that are useful for both teaching and world class academic research are not necessarily the same as those that make sense to business. Such a culture of collaboration is more likely to develop in some environments than others. For example, larger research groups may have developed more effective models of networking through established structures such as forums, conferences or events that have helped to build relationships between universities and business in the longer term. Additionally, as industrial science is rarely within a single discipline and business will typically work with many partners, universities with a culture of interdisciplinary working and that are familiar with quickly building trust within this work may be best placed to make the most of collaborations with business.

Finally, for collaborations between business and universities to be successful, there needs to be the appropriate institutional environment, including the right resources and infrastructure. Within business this can mean adopting approaches such as 'open innovation' to promote knowledge exchange. It can also mean investing in in-house R&D to ensure that the companies maintain sufficient absorptive capacity to engage effectively with the research base. University partners can help to set up the right environment by ensuring that legal agreements in place around collaborations are easy to execute, allow a flow of expertise within the collaboration, and clearly assign intellectual property rights (IPR) that are appropriate, flexible and readily exploited. The presence of a professional and experienced business relations or technology transfer office can be a significant advantage. Third parties, such as local government and research funders, whether working directly to help administer the collaboration or providing co-investment, can be very effective in encouraging collaborations through a support network by freeing up resources within academic departments and helping to de-risk investments made by companies through specific support and leveraged investment.

3. What barriers do individual businesses face in developing long-term research collaborations with academic partners and how can these be overcome?

There is strong evidence that those businesses that invest effectively in their own R&D teams and those that also work collaboratively with universities can make significant gains from public investment in research and increase their total factor productivity growth by more than those with lower R&D investment and less collaboration.³ Without adequate resourcing, R&D teams may find it difficult to explore ventures outside their core business activities, with little capacity or resource to offer other organisations. Businesses may also lack the 'absorptive capacity' required to work with leading research groups in universities. All this points towards a significant barrier to the overall level of business-academia collaboration in the UK: the relatively low level of UK business R&D investment⁴. In any strategy to increase the number and value of collaborations, this low level of investment must be addressed.

Closely associated with this, low internal R&D capacity may also result in a failure to develop staff with the specific skills, experience and knowledge required to build relationships, including knowing who to approach, when to make an approach, an ability to deal with a range of academic disciplines, and also an understanding of the benefits that can be accrued from partnerships. This can be particularly acute within smaller businesses that may be unlikely ever to have the resources for dedicated staff to create and develop collaborations and partnerships. While there are many technology and innovation centres on the landscape, unlike in previous decades, there are no longer many government and industry-centred research labs with a continuity of funding and that are well-equipped to reach out to SMEs. The universities are presumably the organisations which must now bridge this communication gap, but it is not clear that, with some exceptions, they are currently resourced to do so.

Businesses may also face barriers that are geographical. While science is a global endeavour, innovation is local, particularly for smaller businesses. There are fewer than 50 physics departments in the UK and as a result, many UK businesses have no convenient access to a local physics department with which to collaborate⁵. This again may have a particular impact on SMEs who are likely to be more restricted in their ability to reach beyond their local area and requires the development of a programme to engage with these SMEs.

4. What barriers do academics and universities face in developing long-term research collaborations with businesses and how can these be overcome?

Within universities there can be strong cultural, professional and structural barriers to collaborative work. For example, the need for academic researchers to publish results in order to advance their careers may conflict with the requirements for confidentiality agreements which are common in research involving products which are close to the market (for commercial reasons and, in many areas of physics, security reasons). Conversely, universities may be seen to have unrealistic expectations of the value of the intellectual property of their research, and may exert too much control IPR. Businesses and universities must agree clear publication rights and allow for the flexible exploitation of IPR as part of any agreement around collaboration. Similarly, there may be differences between businesses and universities around the perceived level at which collaborative research is conducted. Similar to the challenge of interdisciplinary work, it may be that the areas of focus most relevant to one collaborative organisation may not be seen as 'excellent' or 'cutting edge' by the other. This, combined with a perception from some academic researchers that industrial research is somehow less 'worthy', can have significant effects on researchers and

³ Campaign for Science and Engineering – *The Economic Significance of the UK Science Base* (2014): <http://www.rsc.org/globalassets/04-campaigning-outreach/realising-potential-of-scientists/research-policy/research-innovation/economic-significance-uk-science-base-2014.pdf>

⁴ E.g. OECD science and innovation scoreboard 2013

⁵ Institute of Physics – *Academic Physics Staff in UK Higher Education Institutions* (2012): http://www.iop.org/publications/iop/2012/file_53617.pdf

departments. Perhaps the most direct of these is felt through external funding streams: if the research conducted within a university is perceived to be at a low level by peers, it is less likely to receive funding from research or funding councils with significant impacts on researchers' careers. Such funding is ultimately allocated through peer review, and as such, this is as much a cultural problem as a process problem to be addressed.

The ability of university structures to account for the range of businesses they encounter can also present as a barrier. While SMEs' needs are often acute, they are often also more varied and immediate, requiring universities to be responsive and flexible. Larger businesses often have wider-ranging aims, perhaps more suited to university structures, but universities may then need to ensure that collaboration serves the needs of the researchers, and is not just supplementary to in-house business teams.

Finally, within subjects such as physics, additional challenges may exist as a result of the lack of clear route from research to market. Many of the technologies and innovations that come out of physics research are not in themselves stand-alone products, but are destined to be incorporated into other products and devices, such as electrical components and engine parts, through a chain of companies producing technologies or devices into which new innovations can be incorporated. The lack of clear outcomes can present challenges in understanding and measuring the potential successes of such collaborations within universities and funding agencies. An important role is played here by university technology transfer offices presenting a realistic and informed assessment.

5. How effective are current incentives, policies and funding streams for promoting this type of collaboration? How could these be improved in order to scale up the range and impact of collaborations being undertaken nationally?

Over the past decade several difference schemes have been introduced and developed to promote collaboration. For example, the Higher Education Innovation Funding (HEIF) has provided an additional funding stream to support collaboration while the inclusion of impact case studies in the 2014 Research Excellence Framework (REF) also gave universities strong incentives to think about their collaborations with business; 70% of submitted case studies were on economic impacts. More, however, can be done to provide incentives for academics to pursue impacts from their work.

There is a need to strengthen the role of the research councils in supporting collaboration. This goes beyond specific schemes to encourage collaboration, and is more about culture. There are some positive examples of research councils attempting to address this: EPSRC provide funding streams where cash or in-kind support from business can be recorded and recognised⁶, but such in-kind may not hold as much sway with reviewers or panel members.

An essential component of incentives to business must be to address the needs of businesses looking to de-risk and obtain co-investment where possible, as well as gain access to specialist expertise. While there are many agencies that could fulfil this role, it is often unclear which one will, for example at the interface between the research councils and Innovate UK.

There is also a need to incentivise the development of the skill base in applied research in the UK, so that people have the skills to translate the theoretical to the actual and are able to work between the two. There are several schemes, such as Knowledge Transfer Partnerships and Enterprise Fellowship which work to achieve this with individual researchers. However these piecemeal approaches will not solve the larger problem. To

⁶ EPSRC – *Funding Routes*: <http://www.epsrc.ac.uk/funding/howtoapply/routes/>

succeed in academia the emphasis is still primarily on publication of new ideas, not in research that evolves technology or enables production to be repeatable and affordable.

Finally, and perhaps most importantly, stability and continuity of structures, programmes and funding streams are essential to maintaining the confidence of both universities and business, preserving current partnerships and promoting future collaborations. For example, the Catapult centres have shown the potential to play an important role in connecting uncertainties and businesses, but to succeed they must be allowed to 'bed in' to the landscape and adapt to the different research fields and industrial sectors that they serve.

6. How can progress under the Industrial Strategy be harnessed to stimulate collaboration between businesses and researchers in the UK?

Changing Government procurement practices has the potential to fund and stimulate collaboration between universities and businesses, particularly SMEs. This approach has already had some success in selected areas and departments – the MOD for example⁷ – and should be rolled out across Government. The Government can give further incentives to those suppliers that work closely with universities, and stimulate local areas of innovation, particularly with SMEs, who may often be locked out of tendering opportunities when forced to compete with larger multinational enterprises. This is something that could be operated in partnership with the Catapult centres, allowing them to help in developing innovative proposals of collaborations between universities and business. This would provide incentives and encourage collaboration by providing significantly fewer risks to both partners in any possible collaboration.

7. Which models of collaboration have proved most successful for stimulating SME engagement with the research base in the UK? What additional action needs to be taken to strengthen UK performance in this area?

Smaller businesses, without the resources or the experience to know how to gain access, are much more likely to be disconnected from the knowledge base. As such, smaller businesses in particular need support to broker relationships with universities, particularly due to more acute challenges with regards to time. Universities and research organisations need to work to 'reach out' to SMEs rather than wait for SMEs to come to them. Organisations that can bridge the communication gap between universities and SMEs are vital. The Catapult centres have a role to play here and as they mature their remit should be refined to include specific targets for SME engagement and to encourage such collaboration.

8. Which approaches/sectors/organisations – in the UK or internationally – would you identify as examples of good practice in business-university collaboration with the potential to be applied more widely?

Due to the diversity of possible collaborators in business, and the variation in technologies and different stages of development that can foster collaboration, there is no one size-fits-all approach to business-university collaboration that could be applied more widely. Different technical disciplines have different routes to market and different pathways to integration into products. The complexity of the manufacturing techniques, the level of process control and the challenges of system integration into a product for example are all different and so the types of collaboration between universities and business must reflect that. Where there are certain success factors present, such as a shared understanding of goals and objectives

⁷ MOD – *SME Action Plan* (2014):

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/361985/20140826_SME_Action_Plan.pdf

between organisations, these will increase chances of success, and these factors can be found in several examples.

Physics can point to several successful collaborations between large companies and universities, such as Proctor and Gamble's relationship with Durham University, Rolls-Royce's University Technology Centre's, AWE's work with a number of HEIs and Unilever's Science Grid. For example, Proctor and Gamble and Durham University have built a long-term relationship and have worked on a number of collaborative projects. This relationship has been necessarily multidisciplinary, covering areas including surface sciences, biophysical sciences, electronic goods and manufacturing⁸.

In terms of early careers support, CASE and iCASE (and CAST in Northern Ireland) studentships have been effective tools to develop and strengthen collaborations between universities and businesses and the individuals within them, as well as offering opportunities to young researchers to develop their skills and for businesses to make use of them. Other schemes of note include the Royal Society Industry Fellowship (which is unusual in that it provides an opportunity to give business employees experience in academia as well as vice-versa), the EPSRC industrial internship, KTN secondments and Funded Engineering Doctorates.

Outside the UK, the European Union's collaborative Framework Programmes (FP), including the current Horizon 2020 funding programme (FP8)⁹, have helped encourage close collaboration between universities and businesses. Many of the funding schemes available actively require partnerships to emerge between universities and businesses in order to bid for funding, including promoting consortia within and across Member States, particularly within research and innovation actions, and innovation actions. The promotion of consortia allows partners to develop different roles during these collaborative actions. For SMEs in particular this allows them to build trust and relationships in ways in which they were previously unable to do and enables opportunities for further contract work to develop as a result of the partnership.

⁸ Institute of Physics – *A Clean Solution*: http://www.iop.org/careers/working-life/articles/page_59193.html

⁹ European Commission – *Horizon 2020*: <http://ec.europa.eu/programmes/horizon2020/>