

Interdisciplinarity

Submission from the Royal Academy of Engineering

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About the Royal Academy of Engineering

As the UK's national academy for engineering, we bring together the most successful and talented engineers for a shared purpose: to advance and promote excellence in engineering.

Royal Academy of Engineering's Response to the British Academy's Consultation on Interdisciplinarity

1. The Royal Academy of Engineering is pleased to respond to the British Academy's call for evidence on interdisciplinary research. The Academy is aware that the British Academy will have received evidence from many different sources, consequently this submission is focussed on specific issues raised by the engineering community. As outlined in the call, interdisciplinary research can take many forms: research at the interface between disciplines can be described as interdisciplinary, and over time may create new and distinct disciplines; alternatively the interaction may be of a more transient nature. Irrespective of the nature of the interaction, interdisciplinary research is an important driver of, and contributor to, innovation, which frequently occurs at the interface between disciplines and has the potential to deliver significant benefits, both social and economic.
2. Engineering is a broad, inclusive and continually evolving field with demonstrable impact across the whole of the UK economy, from life sciences and nanotechnology to aerospace and sustainable energy. The breadth and impact of engineering research has been highlighted by an analysis of 514 Research Excellence Framework 2014 (REF2014) impact case studies showcasing the value of engineering research in all of its guises¹. The case studies were drawn from 15 of the 36 REF2014 Units of Assessments, showing that impacts from engineering stretch far beyond the 'obvious' engineering-related fields and it is reasonable to assume that engineering researchers engaged in interdisciplinary research to bring many of these diverse impacts to fruition. Due to the pervasiveness of engineering and the wide reach and potential application of its new developments and discoveries, the engineering sector has an extensive and growing involvement with other sectors and research disciplines. However, in the experience of the engineering community there is still significant room for improvement in the facilitation and support available for interdisciplinary research and researchers.
3. To forge a long-term career in research, in any discipline, suitable funding opportunities need to be available. Without access to funding, research careers cannot be sustained, regardless of how exciting or important the research being undertaken may be. Although access to funding is a universal challenge, there is concern that interdisciplinary researchers may be disproportionately affected and there is a strong perception that funding opportunities for interdisciplinary research are more limited than for those in conventional single-disciplines, as well as tending to be more transient in nature. As a result, while pursuing a career in interdisciplinary research can be highly rewarding, it tends to be viewed as an inherently risky choice, especially for a young researcher. The perceived level of risk is reduced for senior, more established researchers, who are more likely to have permanent jobs and access to more secure funding. It would therefore be desirable to identify measures that could reduce the risks – both real and perceived – for researchers considering careers in interdisciplinary research.
4. Publication records and the Research Excellence Framework are two linked factors that help determine academic career progression in most disciplines. Those pursuing careers in interdisciplinary research may encounter specific challenges. Journals specialising in specific interdisciplinary research by definition tend to represent a very narrow field and consequently can have comparatively low citation rates and impact factors. Publishing in these journals may therefore not be as favourable as publishing in a broader interest journal with a higher impact factor.
5. Furthermore, the involvement of multiple researchers from different disciplines in interdisciplinary research can result in challenging decisions when selecting a journal to submit a publication to, especially if a journal specialising in the interdisciplinary field in question does not exist. Tensions can arise between the different researchers: a journal that possesses a comparatively high impact factor in one discipline may seem exceptionally low to a researcher in a different field; yet the journal with the lower impact factor may be better placed to ensure

¹ [Assess the economic returns of engineering research and postgraduate training in the UK](#), Technopolis Group 2015

dissemination of the research to the most relevant audience. For example, a mechanical engineer and an orthopaedic surgeon together decided to publish their research in a relevant clinical journal, where the technology was more likely to be read about and adopted by fellow clinicians. However, the clinical journal, while well-respected in its field had a comparatively low impact factor when compared to journals within the field of mechanical engineering. Therefore for those pursuing a career in interdisciplinary research it is of particular importance that their publication record is assessed in context of the field in which they work.

6. Journal impact factors are perceived to be closely linked to the REF and despite the REF2014 stating that it would not make any use of journal impact factors, it seems that this message has not yet filtered down to university staff. There is a widespread belief amongst academics that publications from high impact journals are favoured and that these will be a strong factor in promotion criteria.

7. While practising engineers in industry will undoubtedly face challenges that require an interdisciplinary response, the general view among the engineering community is that it would be disadvantageous for undergraduates to pursue interdisciplinary activities until they have developed a thorough grounding in their core subject. Firm foundations within a single discipline set up an individual well to acquire the skills needed to approach interdisciplinary challenges later on in their careers, whether in academia or industry.

8. Nevertheless, it seems that undergraduate students have an appetite to understand and appreciate how their knowledge and skills could be employed in interdisciplinary research. Well-supervised final year research projects can provide a good opportunity to engage and excite undergraduate students in interdisciplinary research, assuming they have a solid foundation of knowledge on which to draw from. Masters degree courses can also provide a valuable mechanism to facilitate interdisciplinary training and research, particularly courses that are taught jointly by multiple departments. Imperial College London, for example, runs an MSc in Sustainable Energy Futures which is taught by experts from 13 of the university's departments.

9. The extent to which a university's structure supports the undertaking of interdisciplinary research varies extensively between institutions. Where appropriate, the creation of physical interdisciplinary centres can be of great benefit to the research community, particularly where the subject is close to becoming a discipline in its own right, as was the case for the Synthetic Biology research centres established by the well-regarded partnership between the Biotechnology and Biological Sciences Research Council (BBSRC) and Engineering and Physical Sciences Research Council (EPSRC). Alternatively physical centres can be established to bring together experts from a wide range of disciplines to tackle large and complex challenges, such as the Southampton Marine and Maritime Institute, at the University of Southampton. However, it is also important to acknowledge that the transient nature of much interdisciplinary research, and the funding opportunities available to support it, mean that virtual centres are often more appropriate. Creation of centres, physical or virtual, requires universities to take a strategic approach to identify and support large thematic interdisciplinary research challenges, often supported by significant investment.

10. The distribution of funding within a university can impact on the extent of interdisciplinary activities within that university. Budgetary responsibility is often held at the departmental level and although this allows for relative flexibility of spending within a department there is a perception that it reinforces the single discipline structures and does not encourage interdisciplinary activity. There is an appetite for funds, held at the university level, to specifically facilitate and support interdisciplinary research, which can be rapidly deployed when new opportunities arise and to 'buy out' the time of an academic from within a department. The availability of such funds would provide a route to addressing the perception that embarking on interdisciplinary research between universities can sometimes be easier than engaging in interdisciplinary research within a university.

11. As outlined in the Academy's submission to the Nurse Review of Research Councils, the Academy believes the Research Councils are well placed to look for opportunities for collaborative interdisciplinary research and proactively encourage their formation. Cross-council working is particularly important when funding and supporting interdisciplinary research, yet interactions between Research Councils are perceived as variable, and vigilance is required to ensure that any gaps between Councils are identified as early as possible. The Research Councils are regarded as having been successful at funding large challenge-led interdisciplinary consortia, but despite the existence of schemes such as sandpits² and discipline-hopping awards³, there is a widespread view in the engineering community that the support of interdisciplinary activities does not satisfactorily extend to the smaller scale responsive-mode grants. These grants play a particularly important role for those starting out in their interdisciplinary research careers.

12. Innovate UK also has a role to play and the Academy has heard evidence regarding the positive contribution made by Catapult Centres to the facilitation of interdisciplinary research involving partners in industry. Such physical hubs can play a valuable part in bringing together parties from different disciplines and sectors for collaborative research and innovation activities.

13. The Academy continues to regard the peer review process as a trusted and reliable way of ensuring that quality prevails in funding and publishing decisions. Nevertheless, there is room for improvement, particularly with regard to interdisciplinary research. In the experience of some in the engineering community there is a tendency for single discipline reviewers to focus exclusively on the elements of the research proposal that align with their own areas of expertise, without appreciating aspects such as the challenge of integrating knowledge or technology from different disciplines. Ideally the review of interdisciplinary research should therefore be conducted by those with relevant interdisciplinary experience and there would be merit in funding bodies such as the Research Councils adopting this practice as standard. Where relevant interdisciplinary experts are not available or do not yet exist, communication between the single-discipline experts is essential to ensure that interdisciplinary proposals are reviewed fairly and thoroughly. The introduction of an iterative digital component to the review process, such as the ability for individual reviewers to provide feedback on other reviewers' comments and scores is one possible solution.

² <https://www.epsrc.ac.uk/funding/howtoapply/routes/network/ideas/whatisasandpit/>

³ <https://www.epsrc.ac.uk/research/ourportfolio/themes/ict/activities/disciplinehopping/>