IOP Institute of Physics

Triennial Review of the Research Councils

Institute of Physics response to a request for input from the Department for Business, Innovation and Skills

A full list of the Institute's submissions to consultations and inquiries can be viewed at www.iop.org

28 February 2013

28 February 2013

Helen Huxtable
Senior Policy Advisor (Europe)
Better Regulation Executive
Department for Business, Innovation and Skills
1 Victoria Street
London SW1H 0ET

IOP Institute of Physics

Dear Helen,

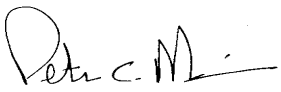
Triennial Review of the Research Councils

The Institute of Physics is a leading scientific society. We are a charitable organisation with a worldwide membership of more than 45,000, 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 Institute welcomes the opportunity to respond to the Triennial Review of the Research Councils. Our response to the questions posed in the call for evidence is presented in the attached annex.

If you need any further information on the points raised, please do not hesitate to contact me.

Yours sincerely,



Professor Peter Main
Director, Education and Science

IOP Institute of Physics

Triennial Review of the Research Councils

PURPOSE

1. Do the Royal Charter objectives for the Research Councils need to continue to be delivered?

The Institute is of the view that it is essential that the Royal Charter objectives for the research councils continue to be delivered. Publicly-funded scientific research is the means by which the UK can maintain its position as an internationally leading knowledge-based economy enabling significant contributions to be made to its gross domestic product (GDP), improving the quality of life of its people, and allowing it to respond to global challenges and opportunities. The research councils have an integral role to play in enabling this by helping to attract and train the brightest graduates who will make significant contributions to many sectors within the UK's economy; supporting and nurturing academics who will undertake internationally leading research, which is the foundation for new discoveries and applications; and to help facilitate innovation.

This ability to attract new, bright academics is further supported by encouraging research excellence across all disciplines through peer review. One of the most important of functions of the research councils is the ability to manage the peer review system allowing them to invest in the best science and engineering research proposals. In the UK, peer review is highly regarded as an invaluable contribution in the selection process and considered to be an international benchmark in research excellence. By exposing researchers to feedback and rigorous scrutiny by a college of experts beyond that available in their own institutions, peer review is a driver of excellence. In addition, it is a way for scientists and engineers to further their knowledge, exchange ideas and challenge each other's thinking, which along with scepticism and openness, fosters a sense of community; a key characteristic of cohesion and driver of success within the sector.

It is vital that these important functions are undertaken at arm's length from the government, whose role is to provide the overarching strategy, by agencies that are populated with knowledgeable administrators and governed by experienced scientists and engineers who have the responsibility for the management of the UK's science and engineering programme. In addition, such agencies must be held to account by the communities they support and parliamentary bodies such as the select committees, amongst others. This is the current state of affairs with the research councils, and we are of the view that, despite the need to see improvements in efficiency for a few functions, the status quo with the remit and operation of the research councils must be maintained.

2. How well aligned do you think Research Council priorities are with these Royal Charter objectives?

On the whole, the priorities are fairly well aligned.

3. How closely are and should Research Council research objectives be aligned with those of Government?

The Institute is of the view that the research councils must retain the ability to set the UK's long-term strategy for science and engineering independently of the government. But this has been a difficult issue for the research councils which, over the years, have been under increasing pressure to justify the Science Budget, thus, we believe, have been gradually shifting their objectives to align with shorter-term economic objectives set by the government in relation to the advancement of technology by favouring the funding of targeted research over responsive-mode research. It is important that this 'mission drift' does not undermine other important objectives such as the advancement of knowledge not immediately coupled to commercial or societal needs.

EFFECTIVENESS AND EFFICIENCY

4. How effective are the Research Councils at delivering their objectives?

The response to this question will focus on the two research councils that are the main UK funders of physics research; the Engineering and Physical Sciences Research Council (EPSRC) and the Science and Technology Facilities Council (STFC).

The current objectives of these research councils include funding world-class UK research through grants for basic and applied research undertaken either in university laboratories or via the exploitation of large national or international facilities. The Institute, overall, is of the view that the mechanisms used by both EPSRC and STFC for these purposes are satisfactory. However, we would like to flag the following issues.

EPSRC's support for postgraduate training:

EPSRC has adopted a thematic approach to research funding which it has applied to the centre for doctoral training (CDT) model, which allows for PhD students to be trained in larger cohorts relating to specialist themes, which can be valuable in providing training in generic skills.

However, there are a number of perceived disadvantages associated with the CDT model of training, which include that it does not readily allow students to predict, embrace or propagate new trains of thought compared with the more traditional method of training via research grants. In addition, whilst increasing its focus on CDTs, EPSRC has implemented a policy to discontinue the provision of project studentships on its research grants and fellowships, which has meant that it is harder to allocate studentships to small-scale projects, distorting the distribution of PhD provision as well as costing more *per capita* than a student supported through EPSRC's doctoral training grant to universities.

The general perception is that CDTs have concentrated studentships in too small a number of places, resulting in a landscape that is extremely patchy both geographically and across research fields, with smaller science, technology, engineering and mathematics (STEM) university departments, many undertaking excellent research, being disproportionately affected. The Institute would like to see EPSRC address these concerns by adopting a broader and more inclusive model for PhD training.

EPSRC's Shaping Capability exercise:

In response to a reduction in resource and capital following the 2010 Comprehensive Spending Review (CSR), EPSRC undertook a prioritisation exercise in 2012, Shaping Capability, which involved EPSRC making judgment on 111 research areas in its portfolio in terms of growing, maintaining or reducing support on the basis of international excellence and further alignment of EPSRC's portfolio to strategic areas of national importance.

The main issue of concern related to the level of community involvement and consultation, which effectively resulted in EPSRC adopting a methodology to cast judgment on research areas which was not transparent, and appeared to be driven by the perceived requirements of users and beneficiaries. Considerable pressure was applied by the learned societies and others to convince EPSRC that it had to do more to ensure that it had the confidence of the community, and that it had to demonstrate transparency about the processes used to reach decisions that would impact upon research areas in its portfolio.

To its credit EPSRC did broaden its engagement with the community, to inform judgment on the research areas that were still under review. To better inform future exercises of this nature, the Institute is of the view that the various programme managers within EPSRC would benefit from the secondment of active scientists from academe or industry for a brief period to assist in the formulation of research priorities.

The genesis of STFC:

STFC was formed in 2007 from the merger of the Particle Physics and Astronomy Research Council (PPARC) with the Council for the Central Laboratory of the Research Councils (CCLRC), with the aim of providing a coherent strategy for the UK's participation in large-scale science. The decision to merge the two councils was generally welcomed by the community and the Institute. However, the genesis of the new research council, in a period of financial difficulty, resulted in a turbulent few years. The remainder of the response to this question focuses on STFC for the sole reason of providing a salutary reminder of the challenges of merging such organisations.

In brief, following CSR07, a number of factors resulted in the newly-formed STFC having to cut £80m from its planned programme over the CSR period. This led to serious consequences for many of STFC's science areas, with the biggest impact in year one of the CSR period. Many of the problems arose due to STFC preparing a Delivery Plan for CSR07, in a short timescale that did not allow for effective consultation, where the balance of capital investment and associated operations and exploitation costs were not optimised.

Following a number of interventions, including the RCUK Review of UK Physics, the Ministerial Review of STFC led by Lord Drayson and the appointment of a new chief executive officer, we now have an established research council which understands the needs of and commands the respect of its community. There have been significant improvements in communication exchange, its operations and processes (e.g. a rigorous and transparent peer review system) and open and transparent consultation (STFC has undertaken well received reviews of its grant funding mechanism, on the structure of its Advisory Panels, and is currently engaged in a Programmatic Review of its scientific priorities with community involvement and

input). As a consequence, STFC has greater stability of its three main functions; research grant funding, international subscriptions, and management of the national facilities.

STFC's functions:

Managing the relationship and tension between these three key interdependent functions, which was one of the motivations behind the formation of STFC, is not without its issues, and whatever the outcome of the Triennial Review, it will be vital to ensure that these functions are preserved in a manner that enables the UK to engage at the very highest level in multinational curiosity-driven and applied research programmes at both national and international facilities.

It is highly desirable that particle physics, astronomy, and nuclear physics (PPAN) remain together as they form an intellectually coherent group of research areas for planning and funding purposes. These high-impact areas of curiosity-driven research need funding for the planning of large, international programmes of research, which includes the development of facilities at the leading edge of technology and their subsequent exploitation.

In addition, it is critical that the exploitation grants for PPAN research reside within the same organisation that pays the international subscriptions for these research areas. Separating these functions would not allow the tensioning of volume increases or decreases in international subscriptions with exploitation based on peer review. It is also important that the PPAN communities that will exploit large facilities are fully engaged in their planning and provision. The exploitation process, via research grants, is therefore intimately associated with the operation of the facilities themselves. Thus, there is no scientific or indeed, administrative advantage at all in separating large facilities from the exploitation.

Furthermore, to enable continuity in the exploitation of both international and national facilities, it is vital that exploitation grants for the PPAN areas are not tensioned directly against either the costs of operating facilities such as the Diamond Light Source, or international subscriptions to facilities such as the European Synchrotron Radiation Facility (ESRF) and the Institut Laue-Langevin (ILL), which are not directly relevant to the PPAN community.

As a result of the Ministerial Review of STFC, it was agreed that BIS would protect STFC from year-on-year changes in international subscriptions which were beyond the control of RCUK. This included short-term fluctuations in exchange rates for the payment of subscriptions to access international facilities which impacted on STFC's budget in an unpredictable manner, as well as changes in GDP or net national income (NNI) and treaty-mandated compensation for inflation to international organisations. This measure allowed STFC to plan ahead for the future without fear of sudden movements in the value of sterling adversely impacting other areas that it has responsibility for. It is absolutely critical that this level of protection is maintained.

Finally, STFC is responsible for the operation and management of the large facilities on behalf of the UK's scientific community. STFC has many fixed costs associated with running national facilities, and one of the long-term concerns has been that the creation of STFC has not solved the problem of balancing capital investment with the operational costs of national facilities, and balancing exploitation research grant funding against operational costs.

In response to a criticism that there was insufficient coordination between STFC's grant funding for exploitation with the other research councils, which meant that the UK did not receive an optimum return from its own facilities, the Ministerial Review of STFC led to RCUK developing the Large Facilities Funding Model (LFFM) which allows it to work more closely with STFC to ascertain the availability and support requirements for the national facilities, at the beginning of each CSR period. The funding for the delivery of these agreed requirements will be allocated separately to STFC by BIS, which would help to further increase STFC's planning ability and will separate the funding of these facilities from STFC's grant-giving function.

The Large Facilities Funding Model:

The Large Facilities Funding Model is now in place, but there is serious concern among the user communities for the facilities that it is not working satisfactorily.

The facilities covered by the model – the Diamond Light Source, ISIS and the Central Laser Facility (CLF) – are world-leading facilities which are national assets for the UK, and should be utilised in the optimum way to ensure that both academic and industrial researchers obtain the maximum benefit from them. This requires a long-term perspective, which is inevitably different from the focus of the research councils (i.e. BBSRC, EPSRC, MRC and NERC) who are members of the Large Facilities Steering Group (LFSG). These are primarily grant-awarding councils with a relatively short-term focus on specific research requirements. Short-term variations in expenditure are particularly hard for large facilities to accommodate, since baseline costs typically represent 90% of operating costs, and thus even a small cut in the operating budget could result in a major reduction in the running time for the delivery of the science programme.

There is a real tension between the short-term focus of the LFSG and the STFC's mandate to operate, maintain and develop these facilities for the benefit of the UK (not just the research councils). To address this, it is imperative that:

- The model is reviewed to ensure a better balance between STFC's mandate and the focus of the LFSG; and
- The LFSG ensures that it effectively liaises and consults the user communities of each of the national facilities in order to have a full picture of the likely demands for beamtime access and to maximise the scientific output of each facility.

In addition, there is also the issue of a defined mechanism for funding the significant step change necessitated by the occasional replacement of an existing national facility by one of the next generation. The last such example was the Diamond Light Source. In addition to the major capital spend itself, there is the need to provide important precursor research and development (R&D) funding to underpin such future facilities, requiring committed strategic support over periods beyond each CSR. This R&D must be an STFC activity but it currently lacks the extensive resources necessary to deliver any such programme beyond an initial exercise. There should be a well-defined mechanism in place to deal with replacement or even new facilities and it is better to plan now rather than wait until the need arises.

5. Are the current disciplinary divisions appropriate to allow the Research Councils to foster excellence and innovation in the research base?

Overall, yes they are. However, there is ongoing concern regarding interdisciplinary research. A good example of this is biological physics. At the interface between EPSRC and the Biotechnology and Biological Sciences Research Council (BBSRC), there is a requirement to identify whether a particular project or collaboration 'really' belongs to biology or the physical sciences before it can enter a research council review process: this skews research priorities and discourages physical scientists from pursuing biological problems.

Both the government and the research councils have been pressing for more interdisciplinary research, as evinced by the cross-council research programmes, and in the formation of, now defunct, university-based interdisciplinary research centres. However, a major barrier to interdisciplinary activity is gaining access to grant funding.

It is rare for an interdisciplinary collaboration to be leading edge in all the disciplines involved. The problem is not that each research council has review panels for individual disciplines. The issue appears to be that of double jeopardy; when an application passes through two or more separate research council review systems, where grant structures, panels and methods for judging grants are different between the research councils, in some cases dramatically so. Grants must be written to match the expectations of a specific research council, a process that can distort research priorities or may lead to refereeing inconsistency.

Altering the boundaries of the divisions between the research councils may benefit some interdisciplinary areas, but no doubt others would inadvertently fall into a similar trap. Mechanisms need to be implemented that overcome the cultural and administrative problems arising when supporting interdisciplinary research, and RCUK has to play a much stronger role in ensuring there is a process for appropriately treating interdisciplinary research proposals.

However, the research councils argue that via the cross-council funding arrangements, they ensure that there is only one peer review process and they have referees from councils with interest; but there is a different perception amongst the community, particularly in areas such as mathematical physics and biological physics that straddle two or more of the research councils.

In order to resolve this, we recommend that the research council mechanism for funding interdisciplinary research (e.g. at the physical and life sciences interface) is reviewed by an independent panel appointed by the government with a view to implementing joint panels for interdisciplinary research proposals.

6. To what extent is there duplication between the functions of the Research Councils (from promoting and support research through to advancing and disseminating knowledge, generating awareness and providing advice) and other providers in the sector?

There is little duplication, as far as we can judge, as each research council looks after its own functions and RCUK provides an overarching coordinating role.

7. What is your view on whether seven Research Councils is the right number?

This is not a straightforward question to answer. From the perspective of an individual discipline, the key question is not how many research councils there are, but whether the needs of a community active in a particular discipline are being met.

For example, physics is a discipline spanning a wide range of sub-areas from medical physics, condensed matter physics to high-energy particle physics, and has strong interdisciplinary relations with several cognate disciplines such as biology, chemistry and various branches of engineering.

Currently, the two main funders of physics research are EPSRC and STFC, but physicists also apply for research funds from BBSRC, the Medical Research Council (MRC) and the Natural Environment Research Council (NERC). The vast majority of academic physicists will apply for funds from EPSRC or STFC either to undertake a research project, or seek access to a national or international facility. The difficulty, as already alluded to, lies with those that are seeking funds for interdisciplinary research areas, which fall between the remit of two or more of the research councils. If there was only one council, like the former Science and Engineering Research Council (SERC), would that improve matters, or would that lead to an unwieldy overly bureaucratic body where the senior staff are distant from the research community? One thing that we can state with a degree of certainty is that the evolution of a transparent peer-review system, the bedrock of the function of the current research councils, would take a significant amount of time to get right with a single, new monolithic Research Council.

It has often been suggested that the functions of EPSRC and STFC could merge. As separate organisations, there is a split between the management of facilities, i.e. STFC, and the users of facilities, i.e. EPSRC (even though users also include MRC, BBSRC, NERC, AHRC and non-research council funded researchers). An apparent solution would be either a merger of the research councils (which could perhaps also solve the issue of funding of areas at the boundaries) or to move the appropriate facilities into EPSRC's remit. This latter option would effectively undermine the *raison d'être* of STFC and is very undesirable, particularly as STFC is now performing much more effectively.

EPSRC's strength is to identify research areas of national and international importance and to use its agility to change direction rapidly when new opportunities arise. In addition, EPSRC is more responsive mode driven (i.e. grant proposals being sent to peer review panels that meet regularly throughout the year, tensioning different areas of physics, for instance, at the individual project level), which means it can be difficult to achieve continuity between one grant award and the next; in contrast, projects in PPAN research areas are planned and exploited over a decade or more and involve large international research groups most often using discipline-specific large scientific facilities, thus are particularly unsuited to EPSRC's current funding mechanisms.

If one of the outcomes of the Triennial Review is to merge one or two of the research councils, there will be short-term costs associated with such a decision; a reminder of what happened with the creation of STFC is instructive. The reasons for undertaking such an exercise would need to be clear and be undertaken with the support and involvement of the community to ensure that the strengths of the existing structures are not lost as a merger could lead to significant disruption to staff focus and funding framework. In the run-up to merging CCLRC and PPARC, the government did undertake a quite detailed consultation exercise, which provided sufficient time for

input. We would expect such an opportunity to be engaged in any such future process. But, as far as we are concerned, we can see no compelling need for any of the research councils to be merged at this point in time, particularly as it is difficult to see how changing the current structure could improve upon the UK's ability to plan and deliver world-class science and engineering research. Nor would it obviously save money, particularly in the short term.

The example of the Shared Services Centre (SSC) provides strong evidence against 'economies of scale' or merging the research councils. The SSC was developed in order to streamline the administrative process, which was thought to lead to increased efficiency both in managing the workload and in utilising financial resources. However, the cost of setting up the SSC was 65% over the allocated budget of £79 million, bringing it up to £130 million, and is cited by the National Audit Office as unlikely to ever make the 'efficiency saving' (i.e. £400 million over 10 years) that was promised. The cost of the merger is partly due to the severe delays which the project experienced. At the time it was commissioned in December 2006, it was estimated that the merger should be completed three years later in 2009. In reality, the project was only completed in March 2011, a delay of 15 months.

In summary, both the SSC and CCLRC/PPARC merger should serve as evidence against mergers based on 'economies of scale' and we should infer that it is often preferable to keep existing structures in place. Based on the lessons learned from the mergers mentioned above, we are of the view that a single research council would not work effectively with its communities without considerable resource devoted to restructuring and it will take years to become efficient and (like the SCC) is unlikely to become more efficient or cost effective than what it has replaced. Instead, we are of the view that the role of RCUK could be strengthened if there is a demonstrable need to streamline cross-council activity.

INTERACTION AND COORDINATION

8. How effective do you consider RCUK to be and why?

As long as RCUK continues to remain in its current existence as an overarching body (i.e. resource efficient and adopting a light touch approach), we hope it continues to be supported in its function in representing the individual research councils as a single voice, particularly in international liaison.

However, as RCUK has no Royal Charter, in order to make it more effective, it needs to be strengthened with a recognisable and mandated role in cross-council activities and to provide strong leadership on cross-council policies and on support services. For instance, RCUK has a key role to play in supporting cross-disciplinary collaboration between the individual research councils, such as between the physical sciences and the life sciences.

9. Are there any functions currently performed by RCUK that you think should be performed at Research Council level or vice versa?

We believe the balance is reasonable at present, but as mentioned earlier, we would like to see RCUK play a much stronger and more effective role in dealing with cross-council topics and issues; for example, we would like to see RCUK take the initiative to rationalise processes such as the individual research councils using different

software for impact and grant reporting, which puts an unnecessary burden on the system and on universities.

10. Where do the Research Councils need to work in partnership and how good are the Research Councils at doing this?

The research councils are currently working in partnership on implementing a policy to move to an open access model to disseminate the results of scientifically published research. Even though there are some issues in relation to RCUK not adopting the government's recommendations to the Institute's satisfaction which is a concern, having to deal with one body rather than several, does make negotiations more straightforward. There are several areas that the research councils need to be working in partnership on, for example, diversity and inclusion policies and practices.

In addition, NERC currently operates six research centres that are intended to enable and encourage science collaborations across their specific fields of research. Some of these centres are more directly linked to universities and their science programmes than others. We are of the view that this function could be improved by strengthening the existing partnerships between the centres and universities. This would have the advantage of encouraging collaborations between centre staff and university staff where appropriate, which would increase the competitiveness of the research on both sides. This could have the additional advantage for university-based researchers to have easier access to all of NERC's data centres, which provide the UK's only record of all environmental aspects, dating back before the 19th century.

11. How good are the Research Councils at challenging the *status quo* – both in the sectors they support and in Government?

Research council attempts to shape the national research landscape to challenge and redirect researchers' priorities are crudely effective – but research is often redirected to new priorities that simply reflect another version of the international *status quo*. This is not an effective way to foster the very best. By definition, truly ground-breaking research is not anticipated by anyone, including the research councils, and certainly not by the government.

12. Do the Research Councils have effective ways to share best practice?

RCUK is the right body to encourage the individual research councils to share best practice in their operating procedures, and to rationalise schemes where possible. Good progress is being made with a number of cross-council initiatives, such as the Concordats to support the career development of researchers, but the Institute is keen to see further examples.

DISSEMINATION AND COMMUNICATION

13. How do Research Councils ensure that use of research is maximised, including by those in other Councils, the private, public and third sector?

The research councils mainly utilise their outreach activities to publicise their research portfolios and maximise the research impact. For example, RCUK provides

support mechanisms such as guidelines on best practice that ensure a consistently high standard of research and enables communication between researchers and industry.

As well as cross-council activities, the individual research councils run their own initiatives to engage with businesses. STFC provides a service that partners businesses with research facilities at universities and laboratories and enables them to use the available equipment, thus forging a direct link between research and industry. Since 2012, EPSRC has run Centres for Innovative Manufacturing with the purpose of addressing major long-term manufacturing research challenges of users. It is worth noting that the research councils in the UK have been considerably more successful than their European counterparts in attracting foreign investment because investors are very keen to make use of the UK's strong research base. Data shows that foreign multinationals perform more than 40% of private sector R&D in the UK.

14. How well do you think the funding mechanisms are understood by applicants (existing and new)?

The responsive mode mechanism is particularly well-understood, and the research councils communicate effectively with the community in terms of providing up-to-date information on funding schemes and revisions to the mechanisms. The EPSRC website, for instance, is comprehensive and well-structured, and presents a good deal of open information.

In terms of EPSRC, its Shaping Capability exercise has led to much confusion about what is required from applicants in completing grant applications for research funds. The need to identify the national importance of a proposal over a 10 to 50 year timeframe, which has been classed as a secondary assessment criterion to research excellence has not been well understood.

Most academics are already concerned about the need to prepare impact plans for grant applications in advance of a research project being undertaken to highlight potential economic and social impact, and in some cases, this has been understood as RCUK recommending that the impact case study informs the direction of the research project; this is something that the research councils have adopted with a strong steer from the government.

Indeed, applicants and referees find it hard and confusing to distinguish between 'national importance' and 'impact'. Referees are reporting being unable to assess effectively how the proposals fit national importance and EPSRC strategy because they contain too little or unclear information for them to judge. Clearly the process is not working well. In addition, there is no agreed working definition of what constitutes 'impact'. Pathways to impact within grants are very different from impact as defined in the research excellence framework (REF) exercise and both definitions are imprecise – there needs to be more rigorous and uniform definitions across the sector.

In response to concerns about the administrative burden caused by its grant funding mechanism, STFC formally engaged with its community and stakeholders to undertake a review in order to put in place a funding system for the exploitation of facilities and experiments for PPAN areas that aimed to guarantee stability, and to signal that the UK is a place to develop a career in the science areas supported by STFC; this is an example of a research council demonstrating good practice and a sound understanding of the needs of its community, which is something that should be adopted by the other research councils.

15. How well do you think Research Councils communicate with the general public?

From what we understand, the research councils do an excellent job on this front, and in particular, we commend the efforts of STFC in its promotion of the research it funds to the public. In the UK, the research councils often work collaboratively to engage the public's interest in research through programmes such as regular activities with schools and teachers and surveys examining public attitude to science, which helps to inform and improve their outreach work. Financial strains have limited their activity (e.g. producing less promotional material), but they have responded well by working in partnership with bodies such as the Institute. Indeed, this is an area where coherent cross-council collaboration would enhance this activity as greater commonality of approach across the research councils would make for a more effective use of limited resources.

FUNDING MECHANISM

16. Is the funding mechanism appropriately open to a range of institutions/researchers, including new entrants as well as incumbents?

The answer is an overwhelming yes for the responsive mode funding mechanism. This funding mechanism remains the jewel in the crown. The process of reports, right to reply and panels rather than standing committees is to be commended. But with the move (e.g. in EPSRC and BBSRC) towards larger grants, it is now more difficult to obtain funding for smaller projects.

In terms of new entrants, the research councils, EPSRC in particular, have taken care to encourage academics early in their careers, with specific programmes for those who are making their first applications. For instance, STFC has a new investigator scheme for those who join groups between the reviews of a consolidated grant. However, STFC tends to fund large research teams and even EPSRC is indicating that it would like to fund larger programmes over longer time periods and focus more strongly on supporting research leaders. This approach is probably sensible, to some extent, as it reduces administrative costs by supporting larger projects and fewer programmes, but it can make it much more difficult for new researchers to make an impact and to develop a portfolio of grants to build up a reputation. It can also disadvantage small project work in research areas, such as mathematical physics, that by their nature do not require large groups.

However, we are concerned by the moves to concentrate research funding to a select number of universities, which contradict the principle of supporting excellence wherever it is found. For instance, over recent years EPSRC has reimagined itself as a sponsor of research rather than a funder of research which has meant the identification of preferred university partners for consultation and advice. This has framed the distribution of funding and the conditions under which universities and individuals in the university are permitted to apply. It is perceived by some that where wider application has been allowed, universities that have been consulted have used prior knowledge of intention and direction to prepare for those calls in a manner that others have not been able to do.

As far as physics is concerned, research in the UK is already highly concentrated and dominated by a few, fairly large physics departments. However, the physics sub-panel of the 2008 research assessment exercise (RAE) revealed that 'excellence' is

spread across the physics base, and is not just the domain of the big departments. We do appreciate that the research councils do not have enough resource to fund all this excellence, and are under pressure to prioritise the research they support, but the UK is in danger of putting all of its eggs in fewer baskets, unless it supports a more diverse range of research, both basic and applied. To reinforce this message, there are the cases of landmark discoveries, such as C_{60}, which were the result of the efforts of small, less fashionable research groups. Such invaluable contributions as these in the future could be threatened by focusing funds on centres with critical mass.

17. Does Research Council funding work well alongside block grants to institutions?

Dual support funding remains a mechanism that generally works well and should be maintained, particularly as it helps to provide the necessary checks and balances preventing a drift towards a system split between research universities, and teaching universities, which would inevitably result if RCUK were the sole distributor of research funding. It is also by far the best mechanism by which university departments can be supported structurally, supporting their teaching activities, and allowing flexibility to support strategic research activities with funding council income, while bidding for project money to support basic and applied research from the research councils.

ECONOMIC IMPACT

18. How good is the UK at attracting private investment and human talent into research in comparison with other countries? What factors influence this?

In 2011, private sector investment in R&D in the UK stood at 1.1% of GDP – £17.4 billion – representing a real-terms spending increase of 6% on the previous year. Perhaps unsurprisingly, it is businesses that are classified as belonging to the 'Science Research and Development' industry that make up the largest part of total R&D investment, 34% in 2011.

It is worth noting that the UK attracts a higher share of its R&D from overseas than any other nation in the G8. In 2012, ownership of businesses that invest in UK R&D was almost equally split between UK and foreign ownership. Foreign multinationals now perform more than 40% of private sector R&D in the UK, with multinationals in the USA alone accounting for 25% of the total. Data show an increasing inward flow of R&D investment from foreign companies keen to take advantage of the UK's research base, skills and regulatory environment. Foreign businesses now own 37% of patents in the UK. By comparison, the figure for the USA is 11.2% and 4.4% for Japan. Clearly, the UK is a world leader in research and prime location for foreign investors. Much of this research is collaborative, bringing together university researchers and those from the private sector. The UK's large charitable sector also invests upwards of £1 billion per annum in research. Continuing public investment in sustaining the UK's currently strong position will ensure that the UK remains attractive to foreign investors in the future.

In terms of human talent, the UK has an excellent track record of attracting talented people into its university department research groups. Statistical analyses undertaken by the Institute have shown that in 2003/04, UK academic staff at all grades in physics significantly outnumbered non-UK academic staff (69% vs. 32%);

however, in 2009/10, the tables turned with non-UK academics in the slight ascendancy (49% vs. 51%).

Further analysis of the data revealed that a smaller proportion of staff are UK nationals at the professorial level for a number of STEM disciplines. Such staff are attracted by the research environment, good infrastructure, and the fact that UK research groups have an internationally acclaimed record of success. In 2010, the Nobel Prize for Physics was awarded to Andre Geim and Konstantin Novoselov, two Russian born physicists based at the University of Manchester that were extensively funded and supported by the research councils. This award exemplified the success the UK has had in attracting and nurturing the best talent from across the world.

However, there are dangers. First, there are various, on-going changes and developments with regards to the immigration system which is placing restrictions on non-UK migrants entering the UK, thus hindering our ability to recruit from an ever growing global pool of research talent. Thankfully, the government, to its credit, changed its plans on the immigration cap relating to science and engineering recruitment at the top end, but then insisted upon a settlement proposal for migrants that could equally be as damaging, whereby they must leave the UK after a period of five years. Irrespective of the correctness of the UK developing various immigration policies and then backtracking, it is sending a negative message to research groups and talent across the world; increasingly scientific research is an international endeavour and forcing talent to choose to work in our competitor nations instead of the UK will have long-term detrimental effects in terms of collaborations which are based on building sound relations.

Second, if investment in UK science and innovation continues to stagnate or decrease, the best UK-based scientists may consider moving overseas. The UK has recently reversed the brain drain and it will be most unfortunate to lose this new talent. In addition, there is the distinct possibility that overseas students and researchers will no longer view the UK as a leading nation in terms of scientific endeavour and discovery and its universities may lose out on the fees income from overseas undergraduates and postgraduates, and on the pool of world-class researchers who may decide to seek employment in the UK's leading competitor nations.

19. How effective is the funding mechanism at delivering value for public money and deciding the best targets for new research?

The responsive mode funding mechanism which is the prime means of funding curiosity-driven research, when operating with the full support of the research councils and the government, has an excellent track record in delivering benefits to the UK's economy.

Curiosity-driven research has an essential role to play in the UK's science base for the considerable future. All technological advances ultimately have their origins in curiosity-driven research, where the outcomes of the research cannot be easily predicted. Such research in physics often leads to significant economic and societal benefits, usually after around a 15 year timescale from essential breakthrough in the science to the application. For example, positron emission tomography (PET), magnetic resonance imaging (MRI), X-rays, the global positioning system (GPS), lasers and semiconductors are all technologies that are widely used and are

enormously beneficial to society. A report by the Russell Group[1] showed that curiosity-driven research can have a far greater economic and societal impact than research carried out with a specific commercial application in mind.

However, there are pressures being placed on responsive mode grants as research is being prioritised towards targeted areas and demonstrable evidence of the economic and societal impact of curiosity-driven research is being sought.

Also, in terms of deciding targets for new research, the Institute appreciates the wish to identify potential growth opportunities in the current economic downturn, i.e. picking winners, but the prediction of the best prospects for future discovery and invention is notoriously difficult. Hence, it is essential for the UK to support a broad research base. It is not clear whether focusing on select, narrow areas will result in short-term economic gains, but it is obvious that in the medium- to long-term, it will undermine the UK's ability to retain the highly trained, inventive and innovative scientists and engineers who will maintain and strengthen the UK's international competitiveness. It is these people, particularly those that have been attracted to the UK by a funding system and academic ethos that allows them to pursue curiosity-driven research, who will enable the UK to respond to new discoveries for which the economic and societal impacts are manifold, but which are broader and harder to quantify than for example, profits in a manufacturing company.

Therefore, the government needs to find a healthy balance between the need to fund curiosity-driven research with longer term impact and the translation of knowledge into products and services that can contribute to the UK's GDP in the shorter term and the need to prioritise research to address the major societal challenges, for example, sustainable energy and global warming.

20. How easy is it for UK businesses, individuals and policy makers to access the research base?

Organisations such as RCUK and the Technology Strategy Board (TSB) provide frequent opportunities for business, for example, through calls for collaborative grants such as the Knowledge Transfer Partnerships. In the UK, websites provided by university research groups cover the majority of research areas, making them an ideal source of information for policy makers and individuals alike. In addition, RCUK puts researchers into contact with relevant Members of Parliament, which is a very constructive collaboration for policy makers.

[1] The Economic and Social Benefits of Research; http://www.russellgroup.ac.uk/home.html

The Institute of Physics is a leading scientific society. We are a charitable organisation with a worldwide membership of more than 45,000, 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.

IOP Institute of Physics

76 Portland Place
London W1B 1NT

Tel: +44 (0) 20 7470 4800
Fax: +44 (0) 20 7470 4848
Email: physics@iop.org
Website: www.iop.org
Registered Charity No. 293851