ANNEX A

Consultation on aspects of the 2010 Science and Research Budget

Response from The Royal Academy of Engineering to Issues raised by the Director General Science and Research

Introduction

The pursuit of excellence across the full spectrum of research has been demonstrated to bring many cultural, economic and societal benefits to the UK. There are sound reasons for enabling all areas of good research to flourish, one being that long-term outcomes can rarely be predicted - nowhere more so than in basic science. Moreover, in the particular case of science and engineering research, there is often a strong and two-way interdependence. The long term health of the UK economy is likely to depend in large measure on our ability to compete successfully with other technologically advanced (and advancing) nations. This argues strongly for retention of the UK's strong science and research base at currently funded levels.

Nonetheless, and with awareness of the important implications, The Royal Academy of Engineering believes that at the current time, and perhaps for the next decade, the central concern for government-funded science and engineering research activity in the UK must be the rebalancing of the economy away from financial services and towards a high-technology based manufacturing sector. This central belief underpins the Academy's responses to the four issues posed by the Director General Science and Research, as follows. These have been ordered to present our arguments in an appropriately logical sequence.

ISSUE1 . Once the overall allocation to the Science and Research Budget is known, how should BIS determine how it is allocated into broad disciplines?

Recommendation 1. The over-riding consideration for BIS should be the impact of research on the economy in the short to medium term. Investment of research funds into engineering and technology will provide the best return to the country compared with other possibilities.

Commentary

a) At a time when the state of the economy in the UK is overwhelmingly the predominant concern of Government and the nation, the available Science and Research budget should be targeted where it will have most impact in the foreseeable future, without compromising future potential as far as possible. Future potential will never be realized if the nation has not created the means to exploit it.

b) Current allocations to disciplines are, in considerable part, a consequence of historical decisions rather than a rational bottom-up assessment of today's national needs and capabilities and the best way to respond to them. This is particularly true of the QR funding stream for research funding of Higher

Education Institutions (HEIs) which is delivered through the Higher Education Funding Councils in the various UK administrations.

c) QR funding recognizes the quality and volume of past research across a range of disciplines and uses an algorithmic approach to the allocation of fractions of this money to individual HEI's. It is delivered free of hypothecation to any discipline for the use by an institution to develop its own strategy. We would strongly argue for the autonomy of HEI's implied by this arrangement; it is undoubtedly a significant reason why UK Higher Education and Research enjoys its current high standing in the world. Nevertheless, we would argue that the system does not necessarily lead to coincidence between institutional strategies and a national strategy.

d) The Academy recognizes that investment in high quality basic science is important for the long term; and that significant outcomes may be completely unpredictable and often not realized until many years after research has been completed. Nevertheless, in today's environment there is a strong case for giving special attention to investment in engineering and technology. Essentially, these are the fields most likely to result in near-term exploitation and to the underpinning of the new high-tech companies which will be essential if wealth is to be created and the economy re-balanced.

e) Against this background, BIS could profitably question how research in a given sub-discipline will: (1) give the UK a technology lead, (2) create new or sustain existing industries, (3) reduce the cost to Government in providing care and health provision, (4) reduce the UK's carbon footprint or (5) support a re-balancing of the economy.

f) This will lead to questions about whether the UK is spending too much research funding in some areas and not enough on engineering, exploitation and wealth-creating science. It is not suggested that those subjects where research funding is reduced should disappear. However, the country cannot currently afford to invest as much in such areas as it presently does and, arguably, the need for solutions to the fascinating problems that lie in some areas of basic science is not urgent.

g) BIS should also consider the productivity of investment by discipline and then sub-discipline. Once the cost of facilities is taken into account it is evident that 'Physics and Maths' receive several times more expenditure per research active academic compared to those in 'Engineering and Technology'. This ratio becomes significantly more extreme if the comparison is made between particle physics researchers and those in engineering and technology. Much of particle physics work is carried out at CERN and other overseas facilities and therefore makes a lower contribution to the intellectual infrastructure of the UK compared to other disciplines. Additionally, although particle physics research is important it makes only a modest contribution to the most important challenges facing society today, as compared with engineering and technology where almost all the research is directly or indirectly relevant to wealth creation.

h) Finally, the Academy has been deeply concerned for more than a decade about the single-minded use by Government of metrics, especially citation analysis, to determine the relative performance of UK research across the disciplines. Where there is no measure of success other than citations by peers, then bibliometrics does reveal something of interest. In an applied subject such as engineering, impact in the context of application is at least as important, arguably more so, than peer assessment. Engineering and technology are far too important to the economy of the UK to be compared with basic sciences in an inappropriate way.

ISSUE 2. In broad numbers, universities receive around £2Bn pa through QR allocation and £2Bn from the research councils on the basis of competitively won grants (RCs fund a further ca £2Bn on facilities, institutions and subscriptions). Is the balance of QR and Research Council funding (that proportion which goes to universities) right, and why?

Recommendation 2: The current balance between QR and funding for RCs is about right. The underlying argument is complex and debatable but the conclusion has clear Academy support.

Commentary

a) The current dual support system provides core Funding Council money selectively allocated (but not hypothecated to specific research areas) to institutions on the basis of research performance (QR), and specific Research Council (RC) grants awarded on the basis of peer review assessment of proposals made within specific themes identified by the Councils or within other areas proposed by researchers

b) RC's fund 80% of the full cost of the research done for them, a level which has been largely accepted by all parties since its introduction. A full analysis of the attendant detail and implications is given in the forthcoming Wakeham Report: *"Financial stability and efficiency in Full Economic Costing of research in UK Higher Education Institutions – a report of a RCUK/UUK Task group"* (to be published mid-June 2010). The detail of this will not be repeated here.

c) However, an important finding in the report is that there remains a £2billion deficit on research done overall in HEI's. Given that RCs fund £2billion of research, it follows that the 20% of the full cost that is not met by RC funding could be provided by, at most, £400 million of QR to support research council funding across the whole sector so that it is sustainable. There is therefore £1.6 Billion of QR available to fund Universities' own research and grow new areas and to underpin research done for public good for other sponsors.

d) It follows that HEI's are doing more research than is sustainably paid for by the public purse and institutions are not recovering it from other funders. The externally funded research will be done for charities, industry and the EU. At the same time UK industry is investing more of its research funding overseas because (it is stated by the CBI) the UK is too expensive, because of the full cost recovery model. There is, in consequence, little hope that the deficit can be overcome by increased charges to many of these other funders; they would simply go overseas.

e) To be more strategic with the research we fund one might move more money to QR. This would either empower each university to have a greater say in the strategy of the country or would require government to control university strategies by interference in institutional autonomy. The latter would be dangerous given the benefits of autonomy that have been demonstrated; and the former is unlikely to produce a coherent national strategy.

f) On the basis that HEI's have had £1.6 billion available per year to be strategic and have run a deficit of £2billion it is arguable that their prime concern is not the strategic interests of the nation. They would certainly find it difficult strategically to disinvest in an area in which they were pre-eminent but which was not economically significant.

g) Since our central tenet is that the prime concern for government should be to focus on the impact of research on the economy in the short to medium term, it could be argued that more of the funding should be provided to RCs but to require them to be individually and collectively responsive to the strategic directions that the country should take, which in our view must be those set out in our response to issue 1 .

h) However, such a shift of strategic intent by research councils would pose new strategic challenges for HEI's because it would require them to invest to change direction.

i) It would, in particular, affect some of the most prestigious universities in the UK. Within their research funding this investment could only come from QR. It is not possible to evaluate how much of the £1.6 Billion of QR HEI's use to subsidise other research funders or indeed teaching. However, the fact that research is in deficit by £2billion suggests that they are using it all and more for this purpose. If that subsidy was further reduced by a reduction in QR then, unless action is taken in HEI's to reduce costs, the research deficit would grow under the scenario outlined. It follows that QR should not be reduced but equally that the volume of research being conducted is too great; that is fuelled by growth incentives.

j) These arguments lead us to conclude that the current balance between QR and funding for RC's is about right because the autonomy endowed by the current level of QR has delivered the strong science base we have. The more strategic direction given in Recommendation 1 above implies that RC's should be more strategic in their portfolio in line with a nationally agreed strategy and choices exercised between them in areas for reduced investment. In the case of engineering, such strategic initiatives should involve industry/academic collaborations; these have already proved to be effective in the sense that industry has collaborated in significant programmes, with EPSRC for example, which directly benefit the economy.

k) However, we observe that the model of rewarding Research Excellence operated by the funding councils includes both quality and volume. Rather than reducing or increasing QR relative to RC funding it would be better to find an improved, strategic model for the distribution of QR within the system - something that recognises quality but is not so directly related to the volume of staff.

l) It is certain that a reduction in QR would have dramatic negative impact on the leading research-intensive universities to a far greater extent than on the less intensive universities where QR is small and HEFCE 'T' funding and top-up fees represent together around 70% or more of total turnover. This implies that alternative funding strategies for QR might aim for more concentration to secure greater economies of scale and research critical mass. This latter point is relevant to the next topic because we believe postgraduate student training and funding is particularly important for the future of research in the UK, in industry and in the universities/research institutes. For them a vibrant extensive and dynamic research culture are often vital.

ISSUE3 . Research Council funding provided to universities is split into competitive grants for projects and programmes and PhD studentships, which exist principally to attract the brightest and best PhD students. What is the appropriate split?

Recommendation 3. If funding is constrained, the balance between RC funds allocated for Engineering PhD studentships and for competitive grants for projects and programmes, compared with other disciplines, should be increased in favour of more PhD studentships. People are the future in research and thus if hard choices have to be made, PG student numbers should ***be*** preserved by restricting their allocation to universities, or environments, where there is a substantial scale of research activity – be this RC funded or otherwise.

Commentary

a) Research at doctorate level is fundamental to the delivery of future technology. Research underway now will provide much of the underpinning science behind products entering service in the next decade and longer. PhDs provide a vital service as education for the individuals concerned and more directly to enable the research to be conducted. Many, if not most, PhD students enter industry or public service rather than remaining in academia; this is arguably a much more effective way in which academic research creates economic value than the commercial exploitation of the science itself. Part of the justification for funding a major project should be its ability to spinout good people as well as its ability to do good science, so adequate funding for PhD students is vital.

b) The overall cash balance between grants and studentships has declined from around 3.5 to 4 down to about 3 over the last decade, mostly because of growth in studentships in the social sciences.

c) Significant project funding is necessary for there to be a possibility of substantive research programmes which in turn provide an essential environment for PhD studentships. Commonly, students undertake research strongly aligned with the main programme activities of the group in which they work – with the attendant economies of scope and scale making this practicable.

d) This applies, of course, only if the students are working alongside a substantial body of other researchers (staff, postdoctoral personnel and other postgraduate students) which is highly desirable in science engineering and technology - with the possible exception of some theoretical work where infrastructure requirements may be much less).

e) People are the future in research and thus if hard choices have to be made, postgraduate student numbers should be preserved by restricting their allocation to universities, or environments, where there is a substantial scale of research activity – be this RC funded or otherwise. This recalls the critical mass argument above.

f) Funding schemes should encourage challenging projects that will develop the skills of the PhD students who work in them. The balance of funding between the project/programme and the studentships should be an output of that design, not an input to it. There should be funding for all the PhD students that a project/programme can properly train and no more. If funding is constrained, a project/programme should not be funded unless there is adequate funding for the PhD students that go with it.

g) Increasing the value of PhD studentships in engineering, as well as the number in engineering at the expense of some other disciplines, would also be effective in attracting the most able young engineers to undertake research. Research with a PhD studentship is often more innovative compared with research tied to a specific research project. The balance between RC funds allocated for Engineering PhD studentships and for competitive grants for projects and programmes, compared with other disciplines, should be increased in favour of more PhD studentships in the case of engineering for exactly the reasons outlined in Recommendation 1.

h) We have already referred to the likely unsustainable levels of research volume in the context of QR. There is also an argument that the system also tends to favour 'more' over 'better' with respect to PhD students.. There has been very significant growth in researcher numbers, roughly doubling in the last decade, and postgraduate numbers have risen as well across the system. It seems unlikely that quality has been maintained at the margins because the number of peer-reviewed papers has not risen by the same amount. The research base would be more effective and deliver better outcomes if PhD support funds were concentrated on fewer institutions in economically important disciplines with better funded students and more fully costed awards.

i) Finally, it should be noted that in engineering research, there is a significant issue in respect of overseas students who do not qualify for RC funding. In some of our most research-intensive universities this is the norm rather than the exception. Overseas students are therefore often appointed on a salary as a Research Associate (RA). The bursary payable from RC funding for UK PhD studentships is equivalent, after taxation is taken into account, to the salaries payable for the lowest level RAs. One way of attracting more UK PhD students would be to increase the stipend, concentrating on quality rather than quantity.

ISSUE 4: All RC funding is allocated to individual Councils but an increasing proportion goes towards cross-cutting multi-disciplinary themes which address grand challenges, for example, living with environmental change. How should BIS and Councils determine that proportion?

Recommendation 4. The Academy advocates a modest reversal of the trend towards defined and prescribed multidisciplinary projects and grand challenges. Thus, multi-disciplinary cross-cutting projects in Research Councils should account for a relatively small percentage of total expenditure. Individual Research Councils should have freedom to assign funding to grand challenges across RCs as they determine.

Commentary

a) Multi-disciplinary research is founded on excellence at the single disciplinary level. It is also the case that research at the single discipline level will often impact directly on a global challenge that is multi-disciplinary. The Academy therefore attaches prime importance to the nurturing of single disciplines ahead of multi-disciplinary activity.

b) Whilst the Academy does recognize the value which comes from recognizing 'grand challenges' it believes that the term should be used sparingly and only when there is an overwhelming case to do so. Grand challenges, by definition, should be issues of unarguable and vital importance for society; it follows that there would be a case for giving such challenges special attention in difficult financial times.

c) However, the Academy does have concerns that the description 'grand challenge' has become over-used in recent times, largely in response to well-intended calls for the demonstration of multi-disciplinarity as a prelude to funding. In the context of the principal theme in our response overall , multi-disciplinarity should be a servant to research that is more focused on a set of areas that are likely to be of medium term economic value, rather than an objective in itself.

d) Universities have largely restructured themselves to reduce or eliminate disciplinary barriers in research and are undoubtedly being strategic about this. The initiatives towards multi-disciplinarity from research councils initially helped and possibly even drove this trend, but now that task is done and it is probably time to allow the bottom-up drive to take over. After all, it is just this drive that has secured the UK's leading position in the world.

e) Thus the Academy would argue that if the RCs set strategic objectives, as was argued earlier, and they develop systems internally to respond effectively to multidisciplinary proposals submitted to them (as opposed to solicited by them) then the objectives set out under Recommendation 1 would be best achieved. The Academy would wish the system to allow individual Research Councils to allocate research funding to a particular grand challenge and to rely on each Council to be generous in its allocation of how funds are split between researchers in different disciplines. This is preferable to involving a number of different Councils.

f) These arguments lead to the suggestion of a modest reversal of the trend towards defined and prescribed multidisciplinary projects and grand challenges. Thus, multi-disciplinary cross-cutting projects in Research Councils should account for a relatively small percentage of total expenditure. In organizations operating at higher Technology Readiness Levels (TRL) it is believed to be reasonable to expect the balance to move more towards multi-disciplinary themes, in the order of 25 – 30% of the total.

g) In conclusion, it is unrealistic to expect substantial research advances from all the multi-disciplinary subjects that might be involved. Underpinning research at the single discipline level is vital.

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