

Ensuring a successful UK research endeavour

A Review of the UK Research Councils
by Paul Nurse

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Foreword

This review was requested by Ministers following publication of the Government's Science and Innovation Strategy. There are many I want to thank for their support in carrying out this review, in particular, the Chief Executives of the Research Councils and members of the Advisory Group, who have been generous with their time in testing and challenging emerging thinking – Professor Lord Kumar Bhattacharyya; Professor Muffy Calder; Professor Sir David Eastwood; Professor Dame Janet Finch; Dr Paul Golby; Professor Ottoline Leyser; Professor Molly Stevens; and Professor Terry Wyatt.

I also wish to thank the following who joined us for individual meetings of this group – Lord David Sainsbury and Professor Lord David Willetts; Dr Ruth McKernan and Sherry Coutu; Professors Dame Sally Davies, Ian Boyd and Chris Whitty; Eddie Morland, Rob Varley and Dr Martin Sené; and Professors Sir Ian Diamond, Michael Arthur, and Alistair Fitt. Likewise, I want to thank other members of the Reference Group to this review for their insights – Professor Tom Cech, Professor Sir Peter Gluckman, Professor Baroness Onora O'Neill, Professor Christiane Nüsslein-Volhard, Professor Sir John Cadogan, Richard Lambert, Professor Sir Konstantin Novoselov, Professor Dame Julia Slingo, Colin Smith and Professor Sir Alan Wilson. I am thankful also to the over 250 respondents to the Call for Evidence issued at the commencement of this review, and to the 2014 Triennial Review of the Research Councils, which have played an integral part in developing understanding of the issues to be tackled in this review. I am particularly grateful to the secretariat provided to me by BIS and the Research Councils to support the review.

I will preface the report by saying that the UK research base is truly world-leading and that the UK Research Councils have played no small part in ensuring that prime position, and this review should be seen in that light. In addition, while the primary focus of the Review is the Research Councils, this can be properly considered only in the context of the wider UK research endeavour, so when appropriate these areas are touched on as well. Finally, the review hopes to build on a strong tradition of such reviews in this country – Viscount Haldane's report of 1918, those of Lords Dainton and Rothschild of 1971, and Lord Waldegrave's report of 1993. These previous reports have all contributed greatly to the present success of the UK research system.

1. Guidelines and principles

In this review the terms ‘research’ and ‘science’ are usually used in the context of the entire academic landscape, reflecting the Latin root, ‘*scientia*’, meaning knowledge. All academic disciplines contribute to the vigour of the research endeavour, including the natural sciences, technologies, medicine, the social sciences, the arts and the humanities.

In tackling the questions set by Ministers at the launch of this Review,¹ I decided it would be helpful to first set out a guide to how a national research endeavour should operate and research funding decisions made, to develop guidelines and principles that can be used to guide how research in the UK can be best carried out. This is the subject of the first Chapter.

WHY DO WE DO RESEARCH?

Research in all disciplines, including the natural and social sciences, medicine, mathematics, technologies, the arts and the humanities, produces knowledge that enhances our culture and civilisation and can be used for the public good. It is aimed at generating knowledge of the natural world and of ourselves, and also at developing that knowledge into useful applications, including driving innovation for sustainable productive economic growth and better public services, improving health, prosperity and the quality of life, and protecting the environment. This has always been the case since the beginning of modern science in the seventeenth century, when Francis Bacon argued that science improved learning and knowledge which “leads to the relief of man’s estate”, and Robert Hooke maintained that “discoveries concerning motion, light, gravity and the heavens helped to improve shipping, watches and engines for trade and carriage”. Today, for advanced nations such as the UK to prosper as knowledge economies, scientific research is essential – both to produce that knowledge and also the skills and people to use it. This is why science should occupy a central place in Government thinking, if the UK is to thrive in our increasingly sophisticated scientific and technological age.

However, scientific research is not solely utilitarian, because it generates knowledge that more generally enhances humanity through culture and civilisation. In the words of Robert Wilson, Director of the Fermi Lab particle accelerator – when asked by the US Congressional Joint Committee on Atomic Energy whether the accelerator in any way involved the security of the country, he replied, “It only has to do with the respect with which we regard one another ... our love of culture..... it has nothing to do directly with defending our country, except to make it worth defending.”²

¹ Terms of Reference for the Nurse Review, Department for Business Innovation and Skills, 2014, BIS/14/1324

² <http://history.fnal.gov/testimony.html>

HOW DO WE FUND RESEARCH?

Research and development in the UK is funded by Government, by companies, and by charitable organisations.

- **Government funded research** is carried out mainly in Universities and to a lesser extent in research institutes, as well as Government Departments, local authorities and other public agencies. It has a number of objectives:
 - to generate openly available knowledge driven by the curiosity of the research community, that underpins subsequent innovation for societal and commercial developments – work carried out primarily in Universities and research institutes;
 - to support research for generating public policy and for the usually non-commercial direct needs of society – work carried out primarily across a wide range of Government Departments and other public agencies;
 - to train the scientific work force and develop the skills necessary for the effective running of the country and its economy; and
 - to effectively monitor research being carried out in the UK and the rest of the world such that the UK can engage with and benefit from world-wide science.
- **Research funded by companies** is usually aimed at developing knowledge into useful commercial applications, an objective that gains from the organisations being close to the customer and the market place. Generally, although not always, this research is restricted in accessibility to maintain commercial advantage. In the UK, research into useful commercial applications tends to be concentrated in certain types of companies, such as the pharmaceutical, IT, aerospace and automotive industries, and in small high tech early stage spin off companies.³ Government often plays a role supporting innovation in private companies, through initiatives such as technology transfer mechanisms, public–private partnerships, research and development tax credits, and other public policy initiatives.
- **Charitable organisations** usually support research into specific objectives of interest to particular philanthropists or philanthropic organisations. This research is usually carried out in Universities or research institutes, and is generally openly available.

The research funded in these different sectors often overlaps because the research endeavour is highly inter-connected. It is carried out in diverse organisations and in different research disciplines, and forms a network of discovery science acquiring new knowledge, of translation of knowledge into innovation, and of developments for applications. It is a complex interactive system, with knowledge generated at different places within the spectrum of activities influencing both upstream in the creation of new discoveries and downstream in the production of new inventions and applications. New discoveries enable new inventions, and new inventions enable new discoveries.

The most effective research systems at producing knowledge for the public good are characterised by freedom of action and movement: they need to be permeable and fluid, allowing the ready transfer of ideas, skills and people in all directions between the different sectors, research disciplines, and various parts of the research endeavour. Artificial barriers which reduce permeability or mutual respect between the different parts of the system should be resisted as they reduce the effectiveness of the research system – both to produce knowledge and for the effective use of that knowledge for applications. Research systems thrive on excellent research scientists who are strongly motivated most often by great curiosity and by the freedom to pursue their intellectual interests, and who make a difference to our understanding of the world – whether from a within a single discipline, or in collaboration with others who can bring different disciplinary perspectives to bear on complex problems.

³ Office for National Statistics, UK Gross Domestic Expenditure on Research and Development, 2013 (published March 2015), Figure 4: Business sector expenditure on R&D performed in the UK, by R&D product group, accessed online at http://www.ons.gov.uk/ons/dcp171778_398876.pdf

THE SCIENTIFIC APPROACH

Scientific research, wherever it is carried out, shares common values and practices. It must be built on a respect for reliable and reproducible data; a sceptical approach which challenges both orthodoxy and the researcher's own ideas; an abhorrence of the falsification or cherry picking of data; and a commitment to the pursuit of truth. Science can only succeed when it is grounded in integrity and ethical behaviour. However, despite sharing many values and practices there are specific differences in the ways that research is carried out in different parts of the system. My characterisation of the system is as follows:

Discovery research, sometimes referred to, in my view less usefully, as pure or basic research, aims at acquiring new knowledge about the natural world and ourselves. It can operate in various ways including empirical, interpretive or normative approaches, but in the natural sciences it most often proceeds through an iterative process of hypothesis generation and challenge, as has been emphasised by Karl Popper.⁴ A researcher considers what is known about the subject of interest, and generates a hypothesis. These hypotheses are then tested by investigating the predictions that they make through experiment and observation. Should the new data obtained not support the hypothesis being tested, then it is either rejected or modified, and new hypotheses tested by further observations and experiments. We can generalise to say scientific research usually proceeds by hypotheses being tested and then being modified or rejected when they are found to be unsatisfactory. This approach is complemented by more exploratory ways of working aimed at accumulating sufficient knowledge to define a field of study and to generate hypotheses that can be tested. In other areas of the research landscape, such as the social sciences and the humanities where the subject matter is human beings and the societies they have created, formal hypothesis testing is not always possible or appropriate, so other research approaches are used. However all research methods share common features: theories built on previous research; empirical testing through the gathering of evidence; impartial and accurate observation; careful collection of relevant data and its rigorous analysis; openness to challenge from other experts; transparency of the whole process.

As a consequence, in any kind of research the ideas driving a study may well change during the course of its investigation. The original hypotheses can change and even the phenomena under study may change in both the natural and the social sciences. An important outcome is that although discovery research is efficient at producing knowledge, it is often difficult to predict where the research may go. Through this mechanism of challenge and modification, the scientific process is essentially self-correcting, and it is this characteristic together with the application of the proper values and practices that make scientific research such a reliable way to gather knowledge.

Applied research, is more goal directed and aimed at achieving specific objectives and outcomes. For this to work successfully there are two necessary conditions:

- For the objectives to be well chosen, which requires understanding of the potential beneficiaries' needs, whether societal or commercial, so that the applications being developed by the research are worthwhile.
- For the knowledge base required for the application to be sufficiently well developed such that effective development of the application is generally foreseeable.

Therefore, research in this part of the system must be based on both knowledge of the relevant phenomena and an understanding of the societal, customer and market or policy needs. Its execution requires a directed approach and frequently needs a diverse, multi-disciplinary skill set. It is often best undertaken in partnership with the potential beneficiaries, promoting the co-production of knowledge. Funding of research is also likely to be more diverse as it sits at the cusp between knowledge generation and application, and so can involve co-funding from Government, commercial and charitable sources.

⁴ Karl R. Popper, *Conjectures and Refutations: The Growth of Scientific Knowledge*, Routledge, 2003 ISBN 0-415-28594-1

Translational research aims to bridge discovery and application research, but is often misunderstood. It can be considered as oriented discovery research, that is research carried out with the expectation that it will produce a base of knowledge likely to form the background to the solution of current or future problems or possibilities.⁵ The objective is essentially to expand the knowledge base in a certain area to a point when more directed development work becomes possible that leads to desired applications. However, there is a danger with some translational activities that if more directed approaches are applied too early, the research may become less responsive to the self-corrective mechanisms crucial for the scientific process, whereby the researcher changes direction as a consequence of new data, ideas and hypotheses – wasting effort to the ultimate detriment of the long-term objectives. If the ultimate driving force is to achieve a specific objective rather than to gain knowledge relevant for that objective, then the researcher may not respond effectively to the signals from new knowledge which indicate that the original aim may not be achievable in that manner. To rush into translation may result in becoming lost in translation.

There can be a natural optimism bias whereby researchers feel that outcomes of their research are closer to application than they really are, and begin pursuing a more goal-directed approach before the state of the knowledge base is ready. A tendency to become too narrowly goal directed too soon is a hazard in carrying out translational research most effectively, and may well be a factor in the rather frequent failures in research based start-ups – although in the latter case, a calculated risk for an investor may well be outweighed by the potential prize. In the translational part of the continuum therefore, while it is important to identify the long-term objective in setting out research priorities, the way the research is carried out needs generally to be more closely aligned to that used in discovery research. The aim of translational research should be to increase the knowledge base to determine what applications may be possible, whereupon more highly directed approaches can be taken. Therefore, while a more directed approach might be needed when the problem to be solved is more urgent, it is usually more effective to identify research objectives in a broadly scoped manner, giving freedom for the individual researcher to propose a specific programme within that wider umbrella, and to pursue that research wherever it may lead.

It should not be thought that discovery, translational and applied research are completely distinct. The boundaries between them can be blurred, with discoveries being made during applied research and applications emerging during discovery research. Nor is it correct to view it as an unidirectional process, moving from discovery through to application – as already mentioned, knowledge transfer occurs in all directions. What is important, is that all three modes must be pursued if a national research endeavour is to be effective in bringing about social and commercial benefits. Generally, but not always, discovery research activities take longer before they lead to benefits than applied research, but when they do so they can lead to very significant benefits. It is difficult to make generalisations about the ideal balance between discovery, translational and applied research because it depends on the nature of different disciplines and particular research programmes. Specific knowledge and understanding of the research area under study is required to make good judgements concerning the appropriate balance between these different modes of research activity.

HOW DO WE DECIDE WHAT TO RESEARCH?

Making good decisions about what research topics and which researchers should be supported is an integral part of the research process, and is crucial for a successful cost effective research endeavour. This requires proper investment in good quality decision making, and should not be seen as an administrative burden, but rather an essential part of the research process, as well as a mechanism to ensuring that research funds are spent wisely and not wasted on inappropriate research.

⁵ OECD (2002), Frascati Manual 2002: Proposed Standard Practice for Surveys on Research and Experimental Development, The Measurement of Scientific and Technological Activities, OECD Publishing, Paris. DOI: <http://dx.doi.org/10.1787/9789264199040-en> (p78)

Doing high quality research is hard and there needs to be a clear focus on excellence, generally best assessed by highly accomplished researchers in the relevant field. Assessment has to be made of both the researchers and the research they plan to undertake, recognising that the actual outcomes achieved may not be what was originally planned. Excellence is essential and the highest standards need to be applied when judging whether research is indeed excellent. Three factors are particularly important for scientific research funding decisions: the researchers undertaking the research; the research programme itself; and the circumstances under which the research is to be pursued.

Who: Research discoveries are usually associated with talented individuals who combine a number of qualities: they need to have in-depth knowledge and the necessary skills, be creative, understand the values of research and how it is done, be motivated, and be effective in what they do. In-depth knowledge is essential but needs to be combined with a wider peripheral understanding of related research activities, especially when a research problem requires multi-disciplinary or inter-disciplinary approaches. Some research problems require a diverse body of researchers with different skills and approaches. Creativity is core and requires freedom of thought and action to pursue an investigation wherever it leads. A researcher who is too strongly directed, or whose thoughts are restrained is unlikely to be fully effective in research. Similarly, in my view, societies which do not encourage freedom will find it harder to excel in research.

What: A proposal describing the research programme allows the research funding body to make an assessment of the grasp that the researcher has of the research field, identifies potential difficulties that may be encountered during execution of the programme, and enables the quality of the proposed research to be judged. The research should tackle an interesting problem and should demonstrate both a creative and a practical approach. In the discovery part of the research continuum the problem being proposed needs to have the potential for scholarly impact, which should be a significant part of any judgement of impact of research activity. A similar approach should be used for most translational research with the ultimate long-term aim of improving the knowledge base relevant for an application of potential societal or commercial benefit. However, as already stressed, the outcome of discovery and translational research activities may turn out to be different, in some cases quite different, to that proposed in the research programme. For research aimed at a specific application a more directed approach is required. There needs to be an assessment of the needs for the customer and of the market in the research application. This will be strengthened if the research proposal includes direct association with, and funding from, the public or commercial bodies interested in the desired outcome. Generally the proposal also needs to include specific milestones indicating progress towards the required goal. These criteria differ from those generally appropriate for discovery and most translational research.

Where: The third issue that needs to be considered in research funding decisions is the location and circumstances under which the research is being carried out. The place or places where the research is to be undertaken should be assessed by judging whether there is adequate infrastructure and whether appropriate colleagues are involved. It is crucial to ensure that it is practical to pursue the research proposed in the proposed location and circumstances where it is to take place, recognising that collaborative arrangements in different locations may also be involved. Centres of research excellence in specific areas help define a satisfactory local environment, but funding mechanisms should be flexible and need to be inclusive, so that support is possible wherever quality research can take place. High quality research can be carried out in a range of research institutions and not just large research intensive Universities. High quality research is also carried out in less research intensive Universities, Government Departments, Public Sector Research establishments, and Research Institutes, for example. Sometimes novel approaches to problems can emerge more readily when carried out away from conventional centres of excellence, which can become too dominated by current fashions and research leaders.

WHAT ARE THE BEST MECHANISMS FOR MAKING FUNDING DECISIONS?

The Haldane Report of 1918⁶ argued what is almost a truism, that decisions about the allocation of research funding are best taken by those who have the expertise and experience to know where it will be best spent. What has been termed the ‘Haldane Principle’, derived from this 1918 Report is usually interpreted a century later as meaning that researchers and not politicians should decide how to spend funds.⁷ It is useful to extend this further so that the decision making process more generally should involve scientists that are close to the research under consideration. For example, scientific research leaders, who may be distant from the specific work being assessed, should focus on high level priorities and avoid becoming too prescriptive and finely grained in recommendations concerning what areas should be funded unless they have received expert and specialised advice. A metaphor here may be useful. In the nineteenth century the Royal Geographical Society in London supporting an expedition might have decided that it wanted to sponsor exploration of the Amazon basin, the source of the Nile, or the Antarctic. But it would have been ill advised to be too fine grained in its deliberations to specify which Amazon tributary or African lake or South Polar glacier should be the focus of attention. That should be left to the explorer on the ground not those in London. In this case, the funder’s role should be to define the general geographical region of interest, identify the best explorer and then properly equip that explorer so they can be most effective in the field.

Research funders should behave in the same way. Generally, research funding decisions should be driven by peer level scientists carrying out relevant research operating at an international level – because they are the ones best placed to come to the best decisions. Moving into the translation phase, review by peer level scientists is likely to need some input from those with the potential to apply the research; who will in turn take a greater leading role in decisions about applied research – although here too, successful decisions always need to be based on the best science. Taken together, this is the reason why a well-run response mode funding system with effective peer review is such a successful and cost-effective way to deliver new scientific knowledge, because it uses those who are best placed to ensure that the right levels of research support are given to the right researchers for the right projects.

Peer review can sometimes be flawed, but with good management and adherence to best practice, these difficulties can be reduced. Factors to be considered are:

- In addition to the specialist experts, other experienced and more generalist researchers need to be involved who are familiar with a range of related research areas and who can bring increased perspective and objectivity to the decision making.
- Assessments of more multi-disciplinary and inter-disciplinary proposals will need a wider range of reviewer expertise, as well as individuals with experience of working in these more complex projects.
- Research proposal assessments for more applied work will also require individuals aware of the market and of the potential customers interested in the long-term outcomes.
- Societal impact should play a role in assessment especially for applied work, but should be proportionate in its use.
- More consideration needs to be given to highly significant scholarly impact, that is, work which has a major influence on a field, resulting in a ‘paradigm shift’ to use the language of Thomas Kuhn.⁸ This is not always so well captured by conventional scientific review and requires the highest quality scientists to make the assessments.

⁶ Ministry of Reconstruction, *Report of Machinery of Government Committee*, December 1918, Cd 9230

⁷ Putting Science and Engineering at the Heart of Government Policy - Innovation, Universities, Science and Skills Committee Contents: The Haldane Principle Today, accessed online at <http://www.publications.parliament.uk/pa/cm200809/cmselect/cmdius/168/16807.htm>

⁸ Kuhn, Thomas, S., “The Structure of Scientific Revolutions”, Second Edition, Enlarged, The University of Chicago Press, Chicago, 1970 (1962)

HOW SCIENCE DELIVERS FOR SOCIETY

In discovery research and much of translational research, the funder generally allows the body of knowledge and capability to grow wherever it may seem most fruitful to the researcher, bearing in mind the duty to maintain the health of specific disciplines. What is then needed are efficient mechanisms for the capture of the knowledge produced when it is relevant for application or for further development, through translation. This may initially require further research in the form of overall synthesis studies and meta-analyses. The key point is that an approach is required in which discovery research is the major driver for knowledge generation, combined with a culture that ensures that knowledge can be efficiently captured when it is likely to be relevant for application.

In more directed and applied research, the funder will shape to some extent how that body of knowledge and capability develops. For example, a charitable funder might decide to invest to improve understanding of a specific disease or societal needs, or the Government might invest in such a way as to address perceived skills gaps for the economy.

Bringing about benefit for society from research introduces the issue of how much politicians should be involved in decision making about research funding. It should always be remembered that publicly funded research consumes significant financial resources which come ultimately from the taxpayer, and are therefore the responsibility of democratically elected representatives. It is usually accepted that politicians, informed by external expert advice should decide on the overall science budget and contribute to the high level allocation of resources, for example, identifying specific challenges and overall infrastructures. These decisions are never fully technocratic, because they need also to reflect the desires of the society that provides that funding, including the views of society's representatives.

However, it is crucial to get the mechanisms right that result in a good relationship between politicians across Government and expert researchers, to ensure that the best decisions are made. For a national research endeavour to be successful there needs to be an effective dialogue and understanding between research scientists, politicians and the public, so that policies and strategies are in place to bring about research that benefits society, and that society will support. Without this engagement and societal endorsement, the research endeavour will ultimately stall or even fail. Good policies and strategies developed by researchers who know how science operates, working together with policy makers and those responsible for societal and commercial interests, are essential for a successful research endeavour. This requires effective working between these organisations and sectors, and a compact that bonds science and society, which will both deliver excellent science and ensure that it is used for the public good.

RECOMMENDATION

1. The following guidelines and principles should be adopted to promote a successful UK research endeavour:

i. Research into the natural sciences, technologies, medicine, the social sciences, the arts and humanities produces knowledge that enhances our culture and civilisation and contributes to the public good, for example through driving a sustainable economy, improving health and the quality of life, and protecting the environment.

ii. As such, research should be at the heart of Government with an effective dialogue and understanding between researchers, politicians and the public, so that policies and strategies are in place to bring about research that benefits society.

iii. Policies need to be in place to bring about high quality, cost-effective research carried out to the highest standards, and to ensure that the knowledge produced benefits society and is supported by society, recognising the differences and similarities between discovery, translational and applied research.

iv. The research endeavour has to be permeable and fluid, allowing the ready transfer of ideas, skills and people in all directions between sectors, research disciplines, the span of the research endeavour, and its potential beneficiaries. The endeavour thrives on excellent scientists, who are often motivated by their curiosity and have the freedom to pursue their intellectual interests.

v. In making research funding decisions account has to be taken of the researcher(s) undertaking the research; the research programme; and the circumstances of the place where the research is to be pursued. High quality peer review plays a central role in this process. The ability of a research endeavour to come to good decisions about what to research, and who should undertake it, is an integral part of the scientific process.

vi. Diversity should be protected in researchers, approaches and locations – recognising that novel approaches and solutions to problems sometimes emerge more readily outside the mainstream. The best research should be funded wherever it is found.

vii. Funders should recognise that delivering the highest quality research is difficult, requiring patience, persistence and long-term investment.

viii. Research funding decisions should be made by those best placed to judge the research:

- Discovery and translational research is usually driven by the scientists themselves close to the research, assessed by high quality peer review operating at an international level, including appropriate expert scientists and experienced scientific generalists; and in the case of translational and applied research an additional awareness of the potential use of the science.
- Applied research needs a more directed approach and knowledge of relevant customer and market needs.
- Assessments of more multi-disciplinary proposals require a wider range of reviewer expertise, as well as individuals with experience of working in these more complex projects.
- Societal impact plays a role in assessment but should be proportionate in use. For example, with discovery research it is not usually appropriate for a fixed proportion of grant assessment to be applied for societal impact. There also is a need for better consideration of highly significant scholarly impact, which can lead to paradigm shifts in understanding.
- Society and its elected representatives should be engaged in the high level questions about the overall direction of science and research, such as the top level allocation of resources, or in respect of needs that society might like to see addressed by research.

2. The Research Councils

The UK Research Councils are funded to advance openly available knowledge, with objectives reflected in their Royal Charters summarised as follows: to promote high quality discovery, translational and applied research; to provide research training; to contribute to the economy and to enhance the quality of life and creative output; to engage and communicate with the public; and to provide advice. The effectiveness of Research Council operations are considered in this Chapter.

In recent years the importance of research for driving productivity in the economy and more generally for the public good, has been recognised by successive governments. This has resulted in the relative protection of the science and research budget which supports the Research Councils – both in financial terms at successive Spending Reviews; and from any competing priorities in successive host Departments, through ring-fencing the expenditure. This ‘science ring-fence’ should be preserved because of the importance of science to the long-term future of the UK, and to provide protection against the inevitable short-term pressures within Government. It is notable that where such protections do not exist, research budgets within many individual Government Departments to help them deliver their own policy objectives have significantly reduced in recent years,⁹ posing a difficult challenge to knowledge based policy making within their respective Departments.

The Research Councils have delivered their objectives very efficiently over many years. This is clear from the findings of the 2014 Triennial Review,¹⁰ the evidence gathered in the consultation for this Review, and the high regard with which they are held throughout the world for delivering the highest quality research in a cost-effective manner.

The Research Councils have deep historic roots: the Medical Research Council (MRC) was established at the time of the First World War in the wake of Lloyd George’s National Insurance Act, which included the provision that *“a penny per working person per year be set aside for the purposes of research.”* As the Research Council system has developed over the last century, its successes have multiplied, contributing in many ways to pushing back the frontiers of science and the scholarly endeavour. Two outstanding examples are the discovery of the structure of DNA at the MRC’s Laboratory of Molecular Biology in 1953 and of the Higgs Boson at CERN in 2012.

As a result the Research Councils rightly have a prestigious reputation, built on a dedication to excellence through high quality and rigorous peer review, response mode funding based largely on the curiosity of research investigators, and high quality leadership from the scientists who have led the Councils. My review should be seen in this context, that the Research Councils have long-term core strengths and a track record of success, reflecting the conclusions of the Triennial Review, which found that “individually they are operating from a position of strength”. They have helped deliver for the UK what is one of the most successful, productive and cost-effective research communities in the world.

⁹ UK Government Expenditure on Science, Engineering and Technology, 2013, Reference Table 4, UK government net expenditure on R&D by department: 2002 to 2013, accessed online at <http://www.ons.gov.uk/ons/rel/rdit1/science--engineering-and-technology-statistics/2013/stb-set-2013.html>

¹⁰ Triennial Review of Research Councils, Final Report, April 2014

The challenge is how the UK can build on these great strengths, especially given that many other countries are not resting on their laurels and, in some cases, are investing very heavily in their own research endeavours.¹¹ What follows is an analysis of where there may be weaknesses with the operation of the Research Councils, and what can be done about them, reflecting the terms of reference of this Review to consider how to “evolve to support research in the most effective ways”. In thinking about this I am grateful to the 2014 Triennial Review that identified a number of issues which have also emerged in the present review, and I shall make specific proposals to try and deal with them. My analyses and recommendations include those concerned with higher level strategy and those concerned with operations and ways of working. They will address three key issues: how operational effectiveness can be enhanced; how interactions with the wider research endeavour can be promoted; and changes to governance and structures which will support the whole.

HIGHER LEVEL STRATEGY

The Research Councils are tasked by their Royal Charters “to promote and support by any means, high quality basic strategic and applied research and related postgraduate training” in their respective disciplines. The UK must maintain research strength across the board, if it is to have an agile research endeavour which can support effectively the needs of the UK. Obviously, the Research Councils should build on pre-existing research strengths but there is also a need to maintain capacity more broadly within the country to be able to respond with agility to new developments and needs. Maintaining a good breadth will help the UK to drive a sustainable economy and improve the quality of life, and is achievable given the size of the UK economy and national ambitions. Good interactions and collaborations with researchers in continental Europe will also help in maintaining appropriate critical mass across disciplines, and wider international collaborations are essential for large experimental infrastructures and programmes, as seen for example with the Large Hadron Collider and the Human Genome project. Such initiatives require long-term commitment if they are to be successful.

In addition to acting as a grant funding machine and where appropriate employing researchers directly, the Research Councils provide the leadership needed to support both the overall vigour and connectivity of the UK research base and to link knowledge with innovation and benefits for society. Reflecting these requirements I would describe the core mission of the Research Councils as follows:

“To provide strategic leadership to the UK research endeavour, building and maintaining national research capability and international competitiveness for the benefit of society, by:

- *Advancing the frontiers of knowledge through investing in the highest quality research, and where necessary by employing researchers and running facilities, across and between the full breadth of disciplines;*
- *Promoting the dissemination and translation of research, and supporting the training and career development of researchers, for the widest possible social and economic benefit; and*
- *Engaging the public with research and advising Governments to inform national research strategy and priorities.”*

¹¹ Department for Business Innovation and Skills, International Benchmarking of the UK Science and Innovation System, a report by Tera Allas, January 2014, Annex E: Summary data on comparator countries’ expenditure on science and innovation, accessed online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/277043/bis-14-544an-insights-from-international-benchmarking-of-the-UK-science-and-innovation-system-annexes-bis-analysis-paper-03.pdf

Scientific Leadership

These are demanding objectives which require accomplished scientific leadership of the Research Councils. To my mind the characteristics of great leadership in this context are as follows:

- Delivering funding for excellent discovery research in a way that builds capacity and secures the UK's continuing status as a world leader across the breadth of disciplines, including interdisciplinary and multi-disciplinary research.
- Delivering funding for translational research and promoting its application for societal benefit.
- Providing appropriate support to the skills pipeline at all levels of research, including fostering the next generation of research leaders.
- Horizon scanning across the entire research endeavour, including outside the Universities, to identify emerging issues regarding the UK's research capability, skills gaps, and longer-term changes in activities throughout the world.
- Working with Government and other partners, both in the UK and overseas, to inform and build national research strategy.
- Understanding and catalysing both new and emerging research areas, responding quickly with the creation of new funding streams and appropriate delivery mechanisms to reflect the requirements of these new research activities.
- Working to ensure that the research is rendered more useful through encouraging effective synthesis, meta-analysis and dissemination.

Discussions with the Research Council leadership during the Review indicated that they are over-stretched, with the day-to-day running of their organisations and the detailed administrative requirements of Government, limiting the time and capacity available for more strategic thinking and for interactions between the Research Councils and across the research community more generally. These administrative burdens distract from broader engagement with Government, which runs the danger of Research Councils "second guessing" what Government is thinking at a deeper level in terms of the interface between science and society, rather than participating in more direct discussion about the research endeavour and how it can be best pursued. A stronger strategic voice for research within Government would be fostered if the Research Councils worked together more closely to both share and reduce the administrative burden and to develop and implement common strategy for engagement with Government. Research Councils UK (RCUK) is a step in this direction, and if this body was strengthened, the voice for research in Government would also be strengthened.

In reducing the administrative burden, I would not propose a return to the approach taken with UK Shared Business Services, (UK SBS), which created too distant a relationship between the administrative support and service delivery, and has not been a success. I propose that the resources available for the provision of administrative support to Research Councils by UK SBS be allocated directly to this strengthened RCUK to arrange delivery of such services. This would have the further advantage of strengthening what is currently RCUK by giving it the tools as well as the responsibility to promote common business approaches appropriate for the Research Councils, in turn simplifying the delivery of research funding, which has been called for in evidence provided to this review. However, it is important to recognise that there will be cases where different approaches will sometimes be required, dependent on a clear rationale base on the particular circumstances of specific disciplines.

Having an effectively run appropriate business support system directly answerable to the Research Councils would relieve some of the administrative burden from the Research Council leadership. Similarly, the reporting demands of Government were also cited as a significant distraction for the Research Council leadership. Each Research Council CEO is an Accounting Officer reporting to Parliament, an important role, but also one with a significant administrative burden. Investing this in a single Accounting Officer at the level of RCUK would also relieve some of the administrative burden from the Research Council leadership. This would require RCUK to be given a formal status with a Chief Executive who would act as the single Accounting Officer. I will return to the details of how such an arrangement could work in Chapter 4. Holding budgets and discipline leadership should be preserved at the level of the individual Research Councils as at present, and the strengths of autonomy maintained, whilst reducing the collective administrative burden. As well as providing greater time and capacity at the Research Council level to focus on strategic thinking, a body at the level of RCUK also provides a forum to develop a combined strategy more generally for the UK research endeavour, for discussion with the research community and Government.

Engaging with the Research Sector

Also critical for generating good strategy is high quality information about research as well as associated data management systems which can effectively capture that information. The process of selecting the best research to fund both requires and generates high quality information about the strengths and weakness of the UK research base. The Research Councils should take collective ownership of the mapping of the UK research landscape, and this high quality information is crucial in enabling them to do so, to produce a consolidated picture of capability across the UK including research supported not just by Research Councils, but also by Innovate UK; HEFCE and its equivalents in Scotland, Wales and Northern Ireland; Government Departments; local authorities and other public agencies; charities and, to the extent that it is possible, industry. This could be based on an extension of the Science and Innovation Audits, and would cover all disciplines and locations throughout the UK, which would be combined together in a single readily accessible and searchable data management system. The Research Councils should also monitor and horizon scan new developments and capabilities in science across the world, making use of the unique access the Councils have to the UK research community. This understanding will support high level strategic discussions, including analysis of strengths, weaknesses and gaps in the UK research portfolio – both within and beyond the Research Councils, as well as knowledge about activities in the rest of the world. Particular attention should be paid to continental European science given the potential for interactions and the funding available for UK science from Europe.

Understanding and engagement is both derived from, and required for, delivering a high quality research funding system and the Research Councils should prioritise engagement with their research and user communities. These activities are core roles for a Research Council, essential to their operations and decision making processes. Efficient and good quality decision making about what research to carry out and who to fund is an essential part of the research process. The decision-making process and the mechanisms for supporting the best research are crucial to the research endeavour and thinking of such support as an administrative overhead can lead to unintended, and potentially harmful, consequences. Eliminating smaller grants, excessive concentration of the research effort, and the imposition of restrictions on who can respond to funding calls, are examples of policy changes that might marginally reduce administration costs, but can also significantly damage research activity.

Research Councils do not just provide financial support to the research sector, but also harness the wisdom of the wider research community in deciding where to invest its resources. This approach supports a continuous emphasis on delivering the very highest-quality research as judged by peer review operating at an international level, and means that Research Councils and the research community both have a duty of care, one towards the other. For example, this is seen in the time provided to the Research Councils by academics to support peer review. But there is also a duty on University management not to overload the Research Council system, and to have due regard for the impact which performance management systems for researchers can have on the Research Council system, if they are focused too much on grant submissions or grants won rather than on research outputs of their faculty. Research Councils and Universities need to work more together to provide incentives for the research community to contribute to Research Council activities such as providing high quality review and serving on Research Council panels; and beyond this, to mentoring more junior colleagues and

participating in public engagement activities. The University sector and the Research Councils should establish a culture that improves effectiveness and encourages collaboration, and not just competition, between institutions. When resources are tighter, the research community naturally becomes more sensitive about the workings of the Research Councils. Better interaction and communication will help build a sense of common purpose and mutual trust between a Research Council and the community it serves.

‘Investing in Excellence, Wherever it is Found’

Most Research Council spending should be in Universities but sometimes, following the principle that the best research should be funded wherever it is found, it is appropriate to support research in other not-for-profit institutions. Examples are Research Council Institutes but also include Charitable Research Institutes and Public Sector Research Establishments. However, there needs to be good and particular reasons for funding in such places. Factors to be considered are institutions that have high level infrastructures shared by many researchers, that carry out research programmes or technology developments difficult to deliver in a conventional University environment, that have a focus on training and capacity building for the UK as a whole, and that promote links and collaborations between Universities. In considering funding in such places it is important to ensure that funding is not being used to subsidise reductions elsewhere (for example within Government Departments) and that there is an emphasis on promoting collaborations with Universities.

Investing in places

One of the questions set at the initiation of this Review was how investments in research can be made effectively in particular places. For example, Government may wish to invest in a particular area of the country to drive productivity, economic growth and development through science and research. There are two factors that need to be borne in mind concerning such investments:

- (1) Supporting excellent science by building on existing world-leading research strengths that are already in place in the area. These strengths could be in the Universities, not-for-profit research institutions, or commercial activities.
- (2) Where appropriate, developing strengths in areas of science which are not well represented in the UK. This approach addresses gaps in UK research capacity, in particular disciplines or technologies. Maintaining a good breadth of research across the scientific disciplines is important for agility in response of the UK to new scientific developments and opportunities.

The Research Councils are well placed to make effective science and research investments in particular research disciplines or technologies. With two key changes, their capability could be applied to the question of how to make effective science and research investments in particular areas.

The first key to being able to deliver good decisions based on excellence and systematic capacity building, is to have access to a high quality map of UK research strength and an understanding of gaps in the landscape and international opportunities. With such knowledge and understanding, Research Councils will be well placed to be able to advise on options for which disciplines or technologies should be invested in an area, such that one could be assured that investment would be delivering world-leading capability for the UK. The second key is the need for a forum for the strategic discussion of such issues – bringing an understanding of the research landscape closer to political decision making. This cannot be delivered at arms’ length, and requires a revised governance structure for science in Government – which this report considers in Chapter 4.

Engaging with other Research Funders

The Research Councils have needed to interact effectively with other parts of the UK research endeavour and the mechanisms by which they are funded. The Science and Research budget has historically been delivered through a ‘dual support system’, one of the bedrocks of UK research, consisting of the Research Councils on the one hand, and the devolved higher education funding bodies on the other – in England, the Higher Education Funding Council for England; and its equivalents in Scotland, Wales, and Northern Ireland. While the Research Councils provide competitive project funding to institutions for projects, programmes, fellowships and studentships on the basis of prospective applications; HEFCE and its equivalents, have provided block grants to institutions on the basis of past performance (assessed most recently in the 2014 Research Excellence Framework), which Universities invest at their own discretion to maintain their research capacity. This complementary system of funding streams gives the system characteristics which one stream of funding alone could not deliver with the same resources. It is one of the reasons behind the UK’s success in research and these separate funding streams should be preserved. However, it is important that there are mechanisms in place to ensure good communications and interactions between the Research Councils and these funders, in England and the devolved nations.

Other important parts of the research endeavour that also require good connections with the Research Councils, are those more concerned with direct applications including within commercial organisations, and within Government to deliver policy objectives, for example in health and safety, weather and climate forecasts, effective education policy, the management of emergencies or great global challenges, such as managing environmental hazards and planning for the needs of an ageing population. These activities can involve Innovate UK and Government Departments, and will be considered further in Chapter 3.

Scientific Culture

Good research of all types requires a high quality research culture with proper regard to good practice and ethical behaviour. Science is a high calling in the pursuit of truth which needs to be pursued in a proper and ethical manner. The Research Councils acting together should ensure that the research they fund is pursued in the appropriate ways, and given the scale and breadth of the research funding they provide they should take a leadership role within the UK for research ethics and culture. This is important for society more generally to maintain trust in the research endeavour. A related point for earning and keeping trust, is good engagement about science with the public at large. Effective communication, dialogue and engagement with the public are essential functions of the Research Councils as reflected in their Charters. This should happen in part at the level of individual Councils, and in part at the level of the Research Councils acting together.

Considerations on the Allocation of Resources

A key issue for the effective running of the Research Councils is an appropriate level of funding. Setting the level of support for the research endeavour as a whole and, more specifically for individual Research Councils, needs to be determined at regular intervals and requires a good interface between the research community through the Research Councils, and society through its elected representatives. At present, mechanisms for engagement between the Research Councils and the Government on these and wider issues of scientific strategy tend to be too much at arm's length, to the detriment of the research endeavour. A potential mechanism for remedying this is considered in Chapter 4. However, some more general points which I would propose be considered in making allocation decisions are made here:

- There are no hard and fast rules that can be applied as to the precise percentage of GDP that should be devoted to the public funding of research. Given the significance of research for driving productivity, economic growth, and societal good, it is important that there is sufficient support to ensure that the UK has an effective knowledge based economy. Comparisons of spend in other countries can provide a good starting point for discussions setting levels of support.
- In delivering an effective research endeavour it is useful to recognise that there are upper and lower bounds to what is optimal. If the boundary is set too high then there is a danger that resources are wasted and the quality of research supported is too low; if the boundary is set too low then the research endeavour becomes inefficient and even dysfunctional, with funding decisions behaving more like a lottery.
- Given the many and varied demands made on the public purse which Government will need to balance, it is probably more likely the funding level will be set too low rather than too high. Below-optimal funding levels results in stress within the research endeavour, wasting time and resources. When the success rate for research grant funding falls too low, decision making can become poor, sometimes focusing on criteria other than research excellence, leading to a drop in morale and a breakdown in trust between funder and researcher.¹²
- Similarly, with the balance between infrastructure spending and resource spending for operations, there is no precise optimum but there are upper and lower boundaries. If infrastructure is allowed to decay too much, then the delivery of research and the effective utilisation of resource spending is damaged. If capital spending becomes restricted, research will suffer because it is mostly a venture that is highly dependent on the latest technologies, methodologies and infrastructures, much of which are dependent on capital spend. Equipment needs to be refreshed and replaced regularly, and laboratory and science infrastructure facilities require renewal to remain effective, while some initiatives such as CERN require particularly long-term commitments in infrastructure funding. Budget needs to be available for this which involves the Research Councils working closely together with Universities and other research institutions and funders. If the upper boundary is exceeded, then laboratories and facilities can be put in place that are under-utilised and can also put the rest of the research endeavour under strain. This can be best dealt with by ensuring that capital investment decisions are made contingent on sufficient resources being in place to ensure efficient operation of the new infrastructures or facilities, and that decisions are supported by good knowledge of the UK research landscape and capability.
- A final point in relation to funding is the importance of mechanisms that ensure agility. If all the Research Council budgets are too heavily committed for extended periods of time into the future, then it becomes difficult to respond rapidly and flexibly to changes in research priorities and to new developments in science, without damage to ongoing activities. Some part of the budget needs to be available to facilitate agility, and financial management systems should be in place to enable such flexibility.

¹² RCUK, Report of the Research Councils UK Efficiency and Effectiveness of Peer Review Project October 2006

OPERATIONS AND WAYS OF WORKING

Some of the higher level strategy issues discussed above can be most constructively addressed by changes in operational ways of working; these are considered below. Others require governance changes, which will be considered more fully in Chapter 4. Other proposals for much needed improvements in ways of working outlined below emerged from responses to the ‘Call for Evidence’ to this review, as well as wider engagement with the community, and could be delivered by the Research Councils’ Grants Transformation Programme:

- *Obtaining high quality peer review reports:* Considerable amounts of time and energy are needed to recruit sufficient high quality referees’ comments on proposals. This is exacerbated by referees feeling unqualified to comment on aspects of the proposals, such as long-term societal impact. As also raised in the recent Triennial Review and in responses to the call for evidence to this review, there are also concerns over the ability of the current system to fairly assess interdisciplinary applications – difficulties in obtaining high quality peer review appears to be a major factor in this. To address these problems I recommend:
 - Operating at an international peer review level, by using high quality reviewers from both the UK and from around the world, and by providing good guidance and training for referees;
 - Developing a recognition system for high quality referees, both to encourage participation in the reviewing process and to drive up the value placed on high quality refereeing by Universities and other research organisations, including considering making it a condition of grant receipt; and
 - Improving the information on Research Council referee databases including in interdisciplinary areas, to allow the better identification and selection of referees with the experience and ability to review proposals effectively.
- *Assembling appropriate peer review panels:* It is essential to maintain diversity on grant panels, while at the same time ensuring panel cohesion. This needs to extend to the use of international peer reviewers who should be used where this is appropriate. Assembling strong panels requires excellent knowledge and understanding of the relevant research communities. A mechanism to recognise those willing to contribute could make it easier for academics to participate. It is harder to recruit panel members from the commercial sector and under-represented communities in the research sector; here high quality engagement with these communities is essential.
- *Operation of grant panels:* There are currently what appear to be arbitrary differences in the operation of grants panels across the Research Councils, for example in the extent to which the panel can moderate the comments of referees. There should be broadly consistent operations across the Research Councils, with mechanisms to share good practice, whilst recognising that sometimes there will be a need to have different ways of working for different Research Councils. Face-to-face interviews provide another mechanism to evaluate grant applications.
- *Speed of the grants assessment process:* The process is currently perceived as being slow. Efforts to speed it up would no doubt be helped by improvements in the ease of obtaining sufficient referees’ reports and effective back office operations. Reviews in research journals have speeded up significantly in recent years and there may be lessons that can be learnt from this sector. Performance standards should be set at decision making within three or four months and never longer than six months from application to decision.
- *Reporting research grant outcomes:* The move to a continuous long-term system for reporting the outcomes of grants is a positive step, since it allows new outputs to be linked to a grant years after it has ended. This is particularly important for building an understanding of the long-term impact of a project. However, the Research Councils’ current system, Researchfish, needs to be made more useful, more effective and more user-friendly.

- *Transparency and feedback:* A strong theme emerging from the consultation is a perceived lack of transparency. This is likely a reflection of the pressures on funding and communication facing both the Research Councils and the research community, but there are specific actions Research Councils can take to counteract unhelpful rumour and speculation:
 - To improve transparency about the grant funding process, they should publish key data not just on headline success rates, but also more granular breakdowns, by research topic for example, that are easily accessible and broadly comparable across Councils;
 - High priority should be afforded to communication with applicants, in particular in the provision of constructive feedback – to bring the wisdom of the wider research community to bear not just on the selection of, but also the development of, research proposals – as well as engagement with the community on priority setting. It is recognised that transparency is not cost-free, and feedback needs to be given in such a way that does not encourage counter-productive and litigious responses, which can become damaging and time-wasting for assessment procedures.
 - Efforts should be made to build widespread understanding of the grant assessment process, for example, opportunities for early career researchers to sit as observers on grant award panels.
- *Ensuring diversity in funding options:* It is very important to ensure that the mechanisms delivering research support are able to support the best research wherever it can be found and by whoever wishes to carry it out. Sometimes initiatives designed for a particular purpose can have unexpected consequences in preventing certain individuals in particular places from applying for support. I recommend the following to deal with issues such as these:
 - Funding mechanisms should be available for pilot, project and programme research support, for operating over a range of timescales; for ensuring flexibility; and for agility in approach. Peer review needs to be flexible enough to adapt to reflect future changes in the way science is conducted.
 - Funding mechanisms should be available for researchers at all stages of a researcher's career, including those working part-time or returning from a career break. It is particularly important that early stage independent research group leaders are able to access support at a time in their career when they may be at their most creative. This is needed to counteract the drift upwards in the career stage of researchers obtaining their first grant support.
 - Doctoral training programmes if too inflexibly applied can prevent graduate students being supervised by quality researchers who are not part of such programmes. Mechanisms should be in place to prevent this unfortunate outcome, by maintaining diversity in the support available for graduate students.
- *Links with the research community:* Part-time secondments of senior researchers to the Research Councils should be considered to improve links and help with strategic discussions. Visits from research grant recipients to the Research Councils would also increase transparency and knowledge of how the funding system works.

RECOMMENDATIONS TO ENHANCE RESEARCH COUNCIL EFFECTIVENESS

2. Research Councils should be focused on providing high quality strategic leadership to their research communities. Engagement with these communities should be prioritised, with the grant decision making process viewed as an integral part of the scientific process, and the Research Councils should work with the sector to determine collectively the most effective approaches to funding research.

3. Research Councils should collectively take ownership of mapping the UK research landscape to produce a consolidated picture of capability across Research Councils, Innovate UK, HEFCE, Government Departments, local authorities, other public agencies and industry and how to access research funding support. They should take responsibility for making these data widely available. This understanding will support high-level strategic discussions including analysis of strengths, weaknesses and gaps in the UK research portfolio.

This could be based on an extension of the Science and Innovation Audit.

4. Research Councils should individually and collectively address the following issues, aimed at enhancing working relationships with their research communities:

- Delivering consistently high quality international level peer review, sharing and promulgating best practice;
- Reviewing of inter-disciplinary research proposals should be improved by using reviewers experienced in judging this type of research;
- Assembling appropriate peer review panels with greater consistency in the operation of subsequent grant award panels;
- Speeding up the grants assessment process;
- Improving outcome reporting systems, transparency and feedback;
- Ensuring diversity in funding options; and
- Strengthening links with the research community.

3. The wider research endeavour

The Research Councils, whilst being the focus of this review, are part of a wider UK-wide research endeavour, and they need to be aware of how they fit into that wider research system – which includes the other half of the dual support system, funding delivered through HEFCE and its equivalents in Scotland, Wales and Northern Ireland; applied research funding supported through Innovate UK; the R&D spend of individual Government Departments and other public agencies; charitably supported research; European and international sources of research funding; and R&D delivered in the private sector. Together these activities form the UK research endeavour and the Research Councils need to help ensure that it works effectively. To this end in this Chapter I will make recommendations as to how Research Councils can interact effectively with the other parts of the research system and as a consequence deliver their objectives more successfully.

ENGAGING WITH INNOVATE UK AND COMMERCIAL RESEARCH

One of the objectives of the Research Councils is to deliver the knowledge and skills base that drives productivity and economic growth, which requires the catalysis of links between the Councils and the business sector where the economic potential of this investment in knowledge and skills is largely realised. To achieve this, the Councils should interact closely with Innovate UK, the UK's innovation agency, which aims to *'fund, support and connect innovative businesses to accelerate sustainable economic growth'*. Innovate UK is responsible for the national network of Catapult Centres and runs a range of programmes that support business innovation. Together, the Research Councils and Innovate UK play a key role in creating an environment in which the knowledge created by discovery and translational research can be effectively captured and turned into useful applications. By utilising their collective convening power, they are able to promote and catalyse interactions between the academic and business communities.

In evidence to this review, Innovate UK have said that, *"In our view, it is essential that translational funding spans the Research Councils and Innovate UK to maintain clear responsibility, commitment and involvement by the research community in the translation of research into economic value and, where the objectives and priorities of Innovate UK and the Research Councils align, this funding should be delivered in collaboration."*

This resonates with Dame Anne Dowling's view that *"closer communication and collaboration between the Research Councils and Innovate UK could further strengthen the offering for collaborative R&D and innovation support"*.¹³ I support these views, and would encourage the continued development of strategic relationships between Innovate UK and the Research Councils, to facilitate a smoother transition of knowledge generated by Research Council funding towards useful commercial application. The path from scientific discovery to the marketplace is complex and is not inevitable. It often needs to draw on research from a range of disciplines. It is usually not easy to map out and demonstrate the direct links between a specific piece of publicly funded research and wealth creation. Most successful applications draw on several streams of research and other factors before being brought into a final process or product. The origin of the world-wide web has been clearly identified with particle physics research at CERN, but even this world-transforming application required other advances and factors to come to fruition, not least in the fields of computer science, fibre optics and computer networking. Although the path from scientific discovery to commercial use is complex, it is self-evident that the innovative applications that form the base for improved productivity and sustainable economic growth in developed nations depends on knowledge. That idea is captured by the concept of the knowledge economy, adopted by most such nations; its reverse is an ignorant economy, a self-evident absurdity. This is why over the years successive UK political leaders have embraced science and research, especially those with particular responsibility for the country's economy.

¹³ The Dowling Review of Business-University Research Collaboration, July 2015 <http://www.raeng.org.uk/publications/reports/the-dowling-review-of-business-university-research>

The key point then is how the knowledge generated by discovery and translational research can be best captured for commercial benefit. A number of proposals are made here to help this transition:

- *Greater engagement of business:* The Research Councils should be aware of the needs and interests of the business sector, particularly small, growing businesses, as this knowledge can help inform the broadly scoped questions identified in their translational research activities. Input from the eventual customers in the commercial sector should be sought by the Research Councils working as appropriate with Innovate UK, which operates closer to commercial customers. It is important to realise that as well as the natural sciences, technologies, and medicine, the creative disciplines of the arts and humanities, as well as the social sciences, have much to contribute to the commercial sector.
- *Simplification of schemes and processes:* This is critical to get more commercial enterprises involved in collaborative programmes. As Dame Ann Dowling's recent review emphasises, there are too many schemes often unhelpfully disguised in a myriad of acronyms. Large companies can perhaps cope, but medium and small sized companies often do not have the resources or time to learn the language, attend the regional consultations, and so forth. Fewer schemes which are simpler, clearer and, where appropriate, consistent and common across Research Councils and Innovate UK, together with united readily accessible data management systems describing clearly the funding options, are urgently required.
- *Improved handling of multidisciplinary research:* Business problems are rarely focused on a single research discipline. By contrast Universities, journals, Research Councils, professional organisations and learned societies are usually organised more on disciplinary lines. The Research Excellence Framework (REF), which has major influence on the behaviour of UK universities, is also largely single discipline based. So using the capability in universities and Research Councils to deliver these objectives, the Research Councils and Innovate UK should work closer together to deliver the multi-disciplinary research needed for business. This also requires peer reviewers with business awareness for applications involving industry, as well of course for many discovery research advances. The selection of reviewers for multi-disciplinary programmes can be difficult given the need for individuals with both sufficient understanding of business need and the multiple disciplines involved.
- *More strategic investment in the skills needed by businesses:* The Research Councils should work with the skills agencies to help businesses get the talent, at all levels, that they need to be internationally competitive.
- *More rapid decision making:* Like academic researchers, businesses need quick answers on research funding applications. Businesses undertaking collaborative applied research programmes cannot work to long timescales if they are to remain competitive, and a three month decision timetable for such collaborative research proposals should be set.
- *Collaboration with Innovate UK:* Given the objectives of Innovate UK, it is generally closer to commercial customers than the Research Councils. Consideration should be given, when appropriate, for Research Council collaborative applied funding to involve Innovate UK. This would combine the research knowledge and capability of the Research Councils with the customer focus of Innovate UK, and could simplify the application process if the majority of enquiries and applications are channelled through Innovate UK.

ENGAGING WITH GOVERNMENT-FUNDED R&D AND PUBLIC SECTOR RESEARCH ESTABLISHMENTS

In addition to Government's broader funding through the ring-fenced science and research budget, Government also makes a number of calls on research in order to carry out its functions, including in the delivery of public services, in the development of policy in the widest sense, *ad hoc* research to support interventions in emergencies, as well as tackling some of the major global challenges where research is essential.

Some of these research needs are met from within Government itself or may be answered directly by scientists, both natural and social, researchers and engineers employed by Government Departments and their agencies, or at arm's length through a network of specialist Public Sector Research Establishments (PSREs) – including the Met Office, the National Physical Laboratory, and the Health and Safety Laboratory. There are also times where calls on the expertise of the wider academic community may provide a better route, in cases where the evidence that is commissioned through peer review mechanisms can bring a depth of expertise or new insights which would otherwise be lacking. Many Government Departments, for example Education or Work and Pensions, have a long history of collaborating with University based researchers; indeed Government Departments have often been funders of social science research, including with major data collection. In addition, good government depends upon the development of richer networks with the wider research community: promoting and sustaining two-way dialogue, creating awareness and understanding of where current research may be of national benefit, and of the nature of both the immediate and longer-term problems facing policy-makers.

In some areas of government, such networks thrive. The approaches of DfID¹⁴ and DEFRA, which engage in joint funding with the Councils, are a useful model here. Measures including the joint development of funding calls, joint selection of peer reviewers, and joint selection of funding panel members between the Research Councils and Government Departments can be helpful. The approach taken by the Department of Health with the MRC also has much to recommend it, with the creation of the Office for the Strategic Coordination of Health Research, (OSCHR) following the Cooksey Review.¹⁵ This allows co-ordination and collaboration between MRC, the Department of Health, philanthropic, and industrial funders, to support the delivery of research for effective clinical care. Recent initiatives to provide effective co-ordination arrangements in the areas of animal and plant health science are another example. Where such circumstances arise, consideration should be given to establishing appropriate structures between other Research Councils and Government Departments, whilst taking care to reduce and not to increase bureaucracy.

Such mechanisms bring a number of benefits: greater synergy and co-ordination between government and other researchers; a focused national conversation between research, industry and government bringing more clarity regarding shared national priorities; and the ability to respond to new and emerging challenges in a prompt and co-ordinated way. The existing frameworks for interaction at working level between government's own research leaders and the Councils elsewhere are however *ad hoc*, and of mixed quality. Some departments are represented on Councils, others are not. The Research Councils and Government need to do more to create the most favourable circumstances for these conversations to develop. On the Government side, procedures need to be further developed to capture the full range of governmental research interests involved, including the natural and social sciences, and the work on evidence gaps in relation to public services, emerging from the network of 'What Works' centres.

¹⁴ RCUK-DFID Concordat, Summary accessed online, October 2016, at <http://www.rcuk.ac.uk/international/funding/collaboration/rcuk-dfid-concordat/>

¹⁵ A review of UK health research funding, Sir David Cooksey, December 2006

Commercial institutions, Government and other public agencies want knowledge that is useful in developing useful applications, including good policy. This may require original research, but it may also entail the systematic use of research resources which have been generated by previous studies, and which require research skills for their analysis. Examples would include the analysis of data from the Census, or from the range of social and economic data available through the UK Data Archive. Harnessing the power of the Research Councils can be useful in this endeavour. With this in mind I make a number of recommendations:

- *Supporting a more systematic expression of Government's own research needs:*
 - There is a need across the full range of Government Departments for a more strategic approach in relation to their departmental R&D programmes. This is partly a matter of securing the right levels of resource, but includes maintaining 'statements of need', in terms of the most important research questions confronting the Departments. These will require work across the Government analytical professions to develop.
 - For effective engagement with the research community, there is also a need for a comparable cross-Government statement regarding Government's overall R&D needs, spanning the full range of Government Departments.
 - The representation of government's own research leaders should be made more systematic within governance structures for specific Research Councils. This may require individuals to cover the research interests of Government more widely, rather than acting with a purely Departmental brief.
- *Supporting Government in addressing its own research needs:* Where Government develops specific research programmes in partnership with Research Councils, suitable programme-specific coordination mechanisms need to be in place to allow for joint planning and oversight.
- *The delivery of excellent research within Public Sector Research Establishments:* PSREs are diverse, with different sizes, and with some carrying out high levels of research. Keeping in mind that research should be funded where it can be most effectively delivered. Research Councils should:
 - In developing strategy, be more aware of the research and capability which exists across the PSRE landscape; and
 - Refresh their eligibility criteria, (which are not always consistent) to:
 - Pilot an approach allowing PSREs to become eligible for Research Council funding where they put forward high quality research proposals relevant to their capability, in collaboration with a University partner. This should not be used as a reason for sponsoring Government Departments to reduce their funding of PSREs; the Departments, not Research Councils, should remain the principle funders of capability, and funders of last resort for PSREs.

I am aware that some University responses in the call for evidence for this Review were not enthusiastic about widening access of Research Council funding to PSREs, with understandable concerns that this would lead to a reduction of Research Council funding to Universities. For the research endeavour as a whole, however, considerations of sectorial protection are less compelling. The proposals outlined here should not put great demands on the funding available, and would involve collaborative work with Universities. PSREs add an extra dimension to the UK research endeavour. They support areas of science helped by delivery at scale, either through facilities or critical mass. In some cases they involve development of state of the art instrumentation requiring teams of engineers, significant infrastructures, and large project management skills. Both they and the Universities would also profit from closer interaction and collaboration.

ENGAGING WITH HEFCE AND THE DEVOLVED HIGHER EDUCATION FUNDING BODIES

As mentioned previously, the dual support system is one of the reasons for the success of the UK research system, providing a stream of stable, institution-focused, performance-driven funding available to all universities, and which complements other sources of research funding. The system is underpinned through periodic research assessment exercises, most recently in the 2014 Research Excellence Framework. This gives the four Higher Education funding bodies functions and perspectives which are different to but complement those of the Research Councils. These include a focus on developing capacity and skills to support the research endeavour into the future and on providing a linkage between high quality research and high quality advanced teaching. In any reformed system, these functions will need to be maintained with a clear focus on excellence.

ENGAGING WITH DEVOLVED GOVERNMENTS

The devolved nature of University funding brings us to how the Research Councils engage not just with the devolved funders, but also the devolved Governments themselves. A healthy and successful research environment supports and encourages open collaboration, recognising distinct needs but without unnecessary barriers to funding and building critical mass. The Research Councils support and develop the best research and researchers across the whole of the UK. It is recognised that there is a need to solicit and respond to distinct research priorities and evidence requirements identified by the devolved administrations, and I recommend this is best done through regular dialogue between relevant UK and devolved Government departments, their officials including Chief Scientific Advisers, and the heads of research at the relevant higher education bodies. To maintain critical mass in research, the devolved nations should look to maintain strong and close scientific interactions and collaborations across the whole of the UK. They should also ensure they have, and respond to, high quality scientific advice in their own structures.

THE CHARITABLE RESEARCH SECTOR

Philanthropically funded research is strong in the UK, with the largest funders being in the biomedical sector. The Wellcome Trust and Cancer Research UK between them fund well over a billion pounds of research each year in the UK. Though smaller, the Leverhulme Trust supports research across the disciplinary spectrum, and the Nuffield Foundation concentrates on social research. Given the overlap in their interests with the Research Councils, it is important that strong contacts are developed and maintained between the Councils and the charitable sector, and when appropriate, collaborations should be developed. In some cases it has been, and will continue to be appropriate, for joint funding approaches to be undertaken on specific initiatives and programmes. To facilitate such interactions and to ensure that proper knowledge and understanding of the entire UK research endeavour is maintained, I recommend particular care is paid to ensuring there are strong interactions between the charitable research sector and the Research Councils.

ENGAGING WITH EUROPE AND INTERNATIONALLY

In terms of engaging with Europe and internationally, I would apply the general principles of inclusivity, permeability, openness and collaboration. Openness to scientific strengths beyond the UK is one of the defining characteristics of the UK research base, and both within Europe and other international fora, we should always look to leverage these strengths. The Research Councils already engage Europe and the rest of the world, and these initiatives should be further strengthened.

While influencing EU policy is challenging and some of the mechanisms and relationships are complex, it is essential that the Research Councils should play a strong role in promoting connectivity and agility across EU research programmes, as well as shaping research priorities and promoting the distinctive requirements of UK research, including in association with the devolved administrations. Similarly UK researchers profit greatly from the large international collaborations, such as high energy physics, astronomy, and molecular biology for example, and continued engagement in those programmes when productive, is strongly encouraged.

RECOMMENDATIONS FOR INTERACTING WITH THE WIDER RESEARCH ENDEAVOUR

5. Collaborative working with business and Innovate UK to simplify the customer interface of the research and innovation funding landscape can be strengthened through:

- Greater engagement of business;
- Simplification of schemes and processes;
- Improved handling of multi- and inter-disciplinary research, and improved selection of peer reviewers with business awareness for applications involving industry;
- More strategic investment in the skills needed by business;
- More rapid decision making; and
- Greater engagement with Innovate UK in collaborative Research Council programmes with business.

6. Collaborative working with Government Departments should be strengthened through:

- A more systematic expression of Government's own research needs and mechanisms for engagement between Councils and Government departments;
- Implementing best practice in co-ordination mechanisms in those areas where Research Councils can help Government address its own research needs; and
- Greater awareness of the research and capability within Public Sector Research Establishments, including through piloting new approaches to funding excellent research within them in collaboration with the University sector.

7. Research Councils should provide leadership and influence in Europe and across the world to influence European and other international research priorities, which in turn play their part in shaping the UK research endeavour.

4. Governance and structures

Ways in which Research Councils can take action to enhance their individual effectiveness were addressed in Chapter 2; and ways which can help them interact more effectively with the wider research system were addressed in Chapter 3. Up till now, this report has essentially considered Research Councils as currently constituted. This Chapter will consider changes to governance arrangements which can support the Research Councils to collectively make up more than the sum of their parts, and help overall Government science strategy and policies to be better developed. The review has identified a number of issues, important for the Research Councils to maintain strong UK science, which can be improved by changes in the governance and structures for research funding and support. These issues can be grouped into five areas:

- Strengthening strategic thinking about research funding and locating research more at the heart of Government through better engagement between policy makers and the research community;
- Developing high level operational policies that share best practice across research activities, establishing effective, optimised, simplified and when appropriate common ways of working, as well as reducing the complexity and increasing the agility of operations;
- Establishing mechanisms to deal with cross-cutting issues such as the support of multi-disciplinary and inter-disciplinary research, grand challenges and the redistribution of resource between Research Councils in response to new developments, advances and priorities in the research endeavour;
- Better co-ordination of the different parts of the research landscape, connecting the Research Councils, the research component of HEFCE, Innovate UK, Government department research, and as far as is possible, commercial and philanthropic research;
- Strengthening Research Council leadership through better support, reducing bureaucratic interference, and by making their governance structures more effective.

It is proposed to change governance structures at three levels: the Research Councils; strengthening cross-Council arrangements; and new cross-Government arrangements. To do this, it is necessary to consider the different levels of governance at which decisions should be taken. A key assumption is that autonomy of decision making is best devolved as far as is possible, except where it is necessary to make decisions at a higher level in order to deliver overall strategy.

The research landscape is wide and covers a range of disciplines with different characteristics and needs. This is very well served by the present arrangements of seven different, discipline-aligned Research Councils, well connected with their research communities and which are highly respected across the world as effective research funding vehicles. However, certain changes to their governance and the relationship between Councils, would help improve strategic thinking and cross-cutting mechanism as well as common and cost effective ways of working.

Primary among them, and one from which a number of important changes can flow, is an evolution of Research Councils UK into a formal organisation with a single Accounting Officer, which can support the whole system to collectively become more than the sum of its parts, through: speaking with a strengthened voice to Government; taking responsibility for delivering cross-Council strategy; and simplifying transactional operations, aimed at reducing the burden of administration currently placed on the heads of Research Councils. As a consequence, they would be freed up to focus on formulating strategy, promoting research, and increasing engagement with their research communities. I propose that this new organisation is called Research UK (RUK).

(I) RESEARCH UK

Research UK should be constituted as a non-Departmental public body, at arms' length from Government, but forming a single body with which BIS interacts. It should have wider responsibilities than RCUK, towards both the Research Councils and Government.

The Chief Executive

The Chief Executive of Research UK would become the Accounting Officer collectively for all the Research Councils, reporting to a single oversight Board, and should be a highly distinguished scientist, capable of delivering a managerially efficient organisation and of interacting effectively with Government.

Governance and Oversight

The Chief Executive would report to the RUK Board, which would provide oversight and consist of an independent Chair and non-executive directors including individuals with appropriate corporate governance skills and high-quality scientific leaders familiar with the academic, philanthropic and business research communities. Further representatives of the executive side, as discussed later, should also be present. The Research UK Board would be appointed by Ministers, and would report to the responsible Director General in BIS, who would, in keeping with Government practice, attend the Board in an *ex officio* capacity. The makeup of this Board has some similarities with the Advisory Board of the Research Councils (ABRC) which was a consequence of Lord Dainton's report of 1971, and as here had in its membership senior members of the academic community; but the RUK Board would be more effective by operating through Research UK. The Board would have responsibility, in tandem with the Executive Committee of Research UK, for advising Government on 'policy for science'.

The Executive Committee

The Chief Executive of Research UK would be appointed by Ministers, with advice from the RUK Board. With a small, strategic core, the Chief Executive would be supported by an Executive Committee including the seven heads of the Research Councils. Collectively, the Chief Executive and their Executive Committee would be responsible for the discharging of five primary roles:

- *First*, for the establishment of best practice in research funding, optimising effective procedures, and when appropriate, establishing common ways of working, simplifying operations and access for support from all parts of the research community. It should be noted that approaches taken by different Research Councils will sometimes differ for good reasons, and when that is the case then these differences should be respected.
- *Second*, to enhance and expand present data management systems so they are readily accessible and searchable and describe all Government funded research, and as far as possible philanthropic and openly available commercial research activities. These need to provide a one-stop mechanism for all enquiries about UK research activities, as well as to how research funding can be accessed, and effective interactions established, so access is straightforward for all parts of the research community. These include commercial and Government departmental activities, as well as the science and innovation activities in embassies abroad. Data science methods should also provide information important for strategic discussions including strengths and weaknesses by research area and by geographical location, as well as gaps in the UK research portfolio. This could be based on an extension of the Science and Innovation Audit.

- *Third*, to support cross-cutting activity across the Research Councils, a common research fund should be established. This would support: (i) multi-disciplinary and inter-disciplinary research, receiving bids for activities that cross boundaries between the Research Councils, or between the Research Councils and Innovate UK or Government Departments; (ii) proposals for research to address cross-cutting societal needs, including grand challenges, and responses to emergency situations; and (iii) to support the adjustment of individual Research Council portfolios in response to scientific developments which open up new opportunities – this would be supported by horizon scanning at the individual Research Council level, and be brought about by competitive discussion between the Research Councils carried out at Research UK level. This latter function will improve agility to respond to new initiatives and when necessary promote reallocation of resource between Research Councils, recognising that such changes take time to implement if disruption is to be minimised. The effectiveness of these new initiatives should be assessed after a period of time to determine if the increased resource should be allocated in the long-term to a particular Research Council, either through injection of new funds overall, or by the redistribution of funds between the Research Councils, and Ministers advised accordingly.

The amount held in this common Research UK fund should be sufficient to support the above activities, but not too large as to interfere with the effective running of each Research Council. The funds for emergency purposes would cover research needed to respond effectively to epidemics, volcanoes, flooding and earthquakes for example. Research Councils should be well prepared for such eventualities by identifying beforehand appropriate experts and by carrying out any peer review that may be needed and can be predicted, prior to the emergencies.

- *Fourth*, the formulation of research strategy. This should build on the increased strategic capacity and empowerment of the individual Research Councils, by analysing and comparing what is proposed by the Councils, and by generating a strong, common strategic position for communication to Government. These discussions should cover at a high level what areas of research and new initiatives should be supported, the mechanisms by which research funding should be delivered, and issues such as the numbers and discipline coverage of the Research Councils, national weaknesses and strengths and the location of research activities throughout the UK. These discussions would allow the Research Councils working within RUK to establish and agree their strategies and priorities and would inform overall budget setting and allocations to individual Research Councils determined by ministers working with RUK. Major budget setting should occur at around three to five year intervals, with generally only minor adjustments in-between, to allow individual Research Councils space to operate effectively and to undertake long-term planning for their activities. Areas where it would make sense to develop a shared strategic approach, for instance international strategy, should also form part of RUK's role. A major objective will be to strengthen the strategic thinking of the research community and to provide an effective way to communicate that voice to Government. Periodically the numbers and discipline coverage of the Research Councils will need to be reviewed.
- *Fifth*, the organisation should take overall responsibility both for ethical and conduct issues in science, and for surveying public opinions about science. The validity of science is based on its values and attributes: honesty, respect for reliable data and observation, a sceptical approach, courtesy in scientific debate and dialogue, consistency, rejection of cherry picking data, and openness and transparency with respect to research and how it is reported. Policies need to be in place to ensure that scientific research is pursued in a manner that respects these values and attributes. Sometimes they will be best developed at the level of the individual Research Council and sometimes at the higher level of the group, but it should be the responsibility of Research UK to ensure appropriate policies and measures are in place, and that they are consistent with each other across the Research Councils. Periodically, say every Government term, public opinions about science and scientific research should be surveyed to help inform decision making by Research Councils individually and collectively. Placing this role close to delivery of research programmes is more likely to lead to a better discussion of public concerns and needs in the context of research delivery.

Ensuring Agility and Maintaining Capability

The UK research endeavour has to be agile and have a broad capability at the national level to be able to respond quickly to new emerging scientific opportunities as they arise within the UK or elsewhere in the world, and to deal effectively with emergencies. Both of these require an adequate and appropriate scientific capacity. Maintenance of research capability at a national level is required to correct for skills shortages, and for deficits in capacity. For example, the safe and effective development of nuclear power requires nuclear engineers and nuclear research; if this capability and capacity are lacking then the nation cannot work effectively.

The key requirements for an agile and capable research endeavour are the availability of improved data management systems describing the nation's research activities and their geographical distribution; having horizon scanning processes in place to be aware of future needs and possibilities; and the maintenance of breadth in research activity to ensure basic capacity across the scientific disciplines. Research UK will be the guardian of the appropriate data management systems and will be responsible for the horizon scanning necessary. This will allow the best possible use of existing capability, tapping into excellence wherever it is found, and will identify gaps in research provision and how to fill those gaps in the most effective way. These functions are not all the responsibility of the Research Councils, but the increased responsibility envisaged for Research UK connects with the wider research system that contributes to overall capacity, through Innovate UK and HEFCE, as well as through Government Departments, philanthropic and commercial research.

It is important for agility in response and for ensuring capability, that the nation maintains a wide breadth of research activity appropriate for a country the size of the UK, embedded within the larger endeavour provided by the European environment. The monitoring functions of Research UK will cover the breadth of the UK research endeavour and will also be able to promote breadth and inter-disciplinarity where needed, seeding research activity and proactively importing research skills from the rest of the world, and by the necessary training within the UK. Finally, the Research Councils and other funding agencies should have mechanisms of assessment, funding and support in place that are rapid in response, and that can operate effectively not just in a "call for proposals" manner, but also in more proactive ways. This is required when timely responses are required in dealing with emergencies, and for maintaining capability across disciplines at a national level.

(II) THE RESEARCH COUNCILS

In creating Research UK, it is important that the identities of the Research Councils within Research UK should remain distinct. While a single organisation in governance terms, Research UK should not be seen as a single Research Council. For them to be effective, the integrity of the individual Research Councils within the new structure should be maintained in the following ways.

In relation to the Council membership of the Research Councils:

- retaining the individual discipline-focused Councils, with an independent membership drawn from their respective research communities;
- leaving the appointment of the Council Chairs with Ministers, with advice from Research UK, and allowing Councils, which to be more effective should be smaller than now, to appoint their own members; and
- working, through their Chair, with the Chief Executive of Research UK, to appoint the head of each Research Council.

In relation to the Council executives of the Research Councils:

- maintaining heads of the Research Councils as individuals representing their different disciplines, to whom they would retain responsibility for providing leadership;
- have budgetary control within the Research Councils, with long-term certainty over their budgets and the control to deliver effective funding;
- keep responsibility for the articulation of funding calls, the management of peer review processes, the grant decision-making process, and support of the research which has been funded;
- continuing the practice of appointing advisory boards as appropriate, to support their engagement with their research communities; and
- maintaining the capability, where appropriate, to employ researchers and run facilities directly.

In these ways, the autonomy of the Research Councils in relation to scientific strategy will be maintained – somewhat like the autonomy of the different faculties within a University. Merger into a single Council is not appropriate as it would be disruptive, distance research funding from the research community, reduce agility, and critically make it difficult to recruit the highest quality leadership at the individual discipline level.

This reformed governance structure would better support the individual Research Councils through providing strengthened support to their leadership; promoting greater strategic thinking within Research Councils – which will assist their individual operations; informing discussions at higher governance levels; and strengthening relationships with the research community. For example, individual Research Councils would need to collect data about their activities – which should be incorporated into the data management systems managed collectively by Research UK – and also carry out horizon scanning of research developments across the world, so gaps in the UK research portfolio can be identified and appropriate actions taken. The resulting information should be integrated as far as possible by Research UK in order to inform higher level analysis and strategic discussions both within and between the Research Councils, as well as at higher governance levels.

The Chief Operating Officer

These changes would also enable the creation of a single Chief Operating Officer for the collective organisation, who would take responsibility for delivering administrative support for transactional activities to each Research Council making up Research UK, including that part of the UK Shared Business Services which would be reallocated to support them. The Chief Operating Officer would also be given responsibility for ensuring best practice and strengthening capability across the whole. Bringing operations under a single Chief Operating Officer should assist in generating efficiencies, which would be expected to arise from a greater degree of commonality of funding approaches.

(III) GOVERNMENT DEPARTMENT RESEARCH, HEFCE AND INNOVATE UK

A role of Research UK should be to promote interactions with Innovate UK, HEFCE and Government Departments. Building on the observations and recommendations made in Chapter 3, consideration should be given to the place of each of these in relation to Research UK.

In relation to Government Departmental Research there needs to be connections between the research funded by Research UK and that funded by Government in its different Departments and Public Sector Research Establishments. These connections could be made through the Director General in BIS as a member of the Research UK Board and through their links with individual government departments, the Government Chief Scientific Adviser (GCSA) and the CSAs network.

In relation to HEFCE, there is an argument for incorporating its research functions including the REF within Research UK, although its functions and budgets should be kept distinct from those of the Research Councils. This change would expand the strategic capacity of the new organisation and bring capabilities and ways of working which do not currently lie within the Research Councils, and *vice versa*. In doing so, I make two strong provisos: firstly, that the dual support system should be preserved, with approximately similar budget proportions with the Research Councils as now; and secondly, that HEFCE's current capabilities in relation to maintaining institutional stability, and linkage to skills capacity should, be preserved as components in the new system.

In relation to Innovate UK, as stated earlier, the current delivery landscape is too complex, and there should be a smoother pathway to more applied research. Integrating Innovate UK into the Research UK structure alongside the Research Councils could help such issues to be addressed. However, Innovate UK has a different customer base as well as differences in delivery mechanisms, which Government needs to bear in mind in considering such an approach, and which this review, according to its remit, has not looked at in depth. As with HEFCE, I would also affix one strong proviso, which is that if Government were to consider this, any inclusion of Innovate UK must be done in a way which maintains the integrity of the ring-fence and does not reduce overall funding for research.

At the very least, the Chief Executives of HEFCE and Innovate UK should be represented, on the Executive Committee of Research UK to help promote more coordinated and integrated approaches.

(IV) CROSS-GOVERNMENT ARRANGEMENTS

The arrangements I have discussed in relation to Research UK will bring greater clarity and focus to the treatment of issues within the research and innovation base, where responsibilities lie clearly with BIS Ministers; but there is also a need to ensure that research has its rightful place in the deliberations of Government more broadly. Relevant responsibilities fall to Ministers across Whitehall in relation to their department-specific research activities and budgets, and to the Government Office for Science, which supports the GCSA in advising the Prime Minister and Cabinet on science issues affecting the Government as a whole.

Science and technology increasingly impinges on all aspects of our lives and of Government operations, and there is a need to: (i) understand the accelerating impacts of science and technology on its work; (ii) secure greater engagement between senior policy makers and the research community; and (iii) ensure that Government is well placed to tackle the challenges and opportunities that science and technology present. Science will become increasingly important in our technological age, and scientific evidence needs increasingly to be fully embedded across Government.

The creation of Research UK has the potential to strengthen the Research Councils' voice in government, but I believe that arrangements also need to be put in place which will support better co-ordination and thinking on these wider themes at ministerial and senior official level. Such arrangements would need to:

- Provide a forum for interactions and discussions between policy makers and the research endeavour, including assessment of advice and proposals from Research UK and its partners.
- Secure the capacity of Government as a whole to respond to new and emerging evidence and developments in science, scientific related challenges and major disruptive technologies.
- Address the Government's overall capacity for research. Accountability for budgets should remain with the relevant Government Departments, but there is a need to assess national research capacity in the round.

One mechanism to deliver these roles would be a Ministerial Committee chaired by a senior Minister with cross-cutting cabinet responsibilities. The Committee should also include the Minister for Universities and Science with overall responsibility for delivering the UK science agenda, as well as other Ministers responsible for major science budgets. Relevant senior officials should also be in attendance. The Prime Minister's Council for Science and Technology (CST)¹⁶ could act as the independent advisory group for the Ministerial Committee. The creation of such a committee will ensure that science takes its appropriate place at the heart of Government and would help Ministers across Government to better engage with science leading to a step change in the management of science for the benefit of the UK.

I also considered whether the CST acting alone could provide an alternative to a Ministerial Committee. This is possible, but there would be issues that would need to be addressed if it were to perform this role. The CST could play an increased role in promoting cross-Government discussions concerning science if there were clearer engagement between its advisory activity and the work of key decision-makers. Closer involvement with senior officials from BIS, the Treasury and RUK would be necessary, as would the development of opportunities for direct engagement with Ministers. However, the CST used in this way would lack the political strength of a Ministerial Committee and could potentially confuse the boundaries between independent advice and political action. However with appropriate reconfiguration the CST could make a greater contribution to cross-Government arrangements concerning science.

CONCLUDING REMARKS

The changes proposed through this report are not complex and could be easily adopted without disrupting on-going research activities. Some of the details have been left open, as the efficient implementation of the proposals will profit from engagement of those directly involved in operations. While maintaining the integrity of the Research Councils, the establishment of RUK will deliver cross-cutting activities and better strategic thinking, and the Ministerial Committee will bring about better engagement with Government through refreshed cross-Government arrangements, with the CST providing a possible alternative. These new structures will improve decision making about research, which requires high quality strategic thinking in the research community combined with in-depth knowledge and understanding of the research landscape in Government. These changes will provide effective mechanisms for efficiently generating knowledge and using that knowledge for the public good, and will generate a step change in how research across all disciplines can help make the UK a more prosperous and a better place to live.

Effective government must be based on knowledge and the UK's research endeavour is required to generate that knowledge. Four centuries ago, statesman and philosopher Francis Bacon recognised the importance of knowledge for the proper function of government and the execution of power when he coined the term "knowledge is power". This is still the case today, and the changes I am recommending here are aimed at delivering this more effectively.

¹⁶ Council for Science and Technology, Terms of Reference, accessed on line October 2015; <https://www.gov.uk/government/organisations/council-for-science-and-technology/about/terms-of-reference>

RECOMMENDATIONS ON GOVERNANCE AND STRUCTURES

8. To strengthen Research Councils in the effective formulation of strategy, promotion of research, and engagement with their communities, the partnership of the seven Councils making up RCUK should evolve into Research UK. This would support the seven Councils collectively, would speak with a strengthened voice to Government, take responsibility for cross-Council strategy, and simplify transactional operations, reducing the administrative burden on the Councils.

9. Research UK should be headed by a highly distinguished scientist acting as the single Accounting Officer, reporting to a single oversight Board consisting of an independent Chair; and non-executive directors including the highest quality scientific leaders familiar with the academic, philanthropic and business research communities. There also needs to be connections with and representation from Government Departments, HEFCE, and Innovate UK, better linking the various strands of government funded research. Research UK would have accountability for:

- Establishment of best practice in research funding, implementing harmonisation when appropriate, whilst respecting diversity when necessary.
- Development and maintenance of research data management systems.
- Managing cross-cutting funds for:
 - Multi- and inter-disciplinary research;
 - Research addressing societal needs and emergencies spanning the different Research Councils; and
 - Promoting agility in response to new developments in science and when necessary reallocation of budget between Research Council portfolios.
- Formulation of overall research strategy for the UK.
- Providing leadership on the conduct of research, research ethics and engagement with the public over science.

10. That Government should develop new cross-Government arrangements to enable the discussion of strategic research priorities and funding of research, to provide a place for engagement between policymakers and research funders, and to put science at the heart of Government. It is recommended that a Ministerial Committee is established to perform these roles, although a reconfigured CST could possibly provide an alternative approach.